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ABSTRACT

This document contains the full text of the following invited papers from ICCE/ICCAI 2000 (International Conference on Computers in Education/International Conference on Computer-Assisted Instruction): (1) "Matching the Infoverse: About Knowledge Networks, Knowledge Workers, and Knowledge Robots" (Joachim Hasebrook); (2) "Learning on the Internet: Taking the Ecology Metaphor Further" (Chee-Kit Looi); (3) "What Can We Learn from the Systems We Build? From Providing Support to Students to Providing Support to Teachers" (Pierre Tchounikine and Daniel Luzzati); (4) "Human Activity in Learning Societies" (Robert Lewis); and (5) "Towards Intelligent Media-Oriented Distance Learning and Education Environments" (Toshio Okamoto, Alexandra Cristea, and Mizue Kayama). Abstracts of the following invited papers are also included: "The Role of Emotional Agents in Intelligent Tutoring Systems" (Claude Frasson); "Web Portfolios: Tools for Monitoring and Assessing Learning Process" (Gwo-Dong Chen); "Can and Should Teaching Systems Mimic Human Teachers?" (Benedict du Boulay); and "Research on Internet Addiction: A Review and Further Work" (Chien Chou). (MES)

ICCE/ICCAI 2000 Invited Papers

ICCE / ICCAI 2000

Learning Societies in the New Millennium : Creativity, Caring & Commitments

Proceedings

Content

Invited Papers

▲ HOME

Matching the Infoverse: About Knowledge Networks, Knowledge Workers, and Knowledge Robots

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Humans are not able to cope with the exponential growth of information and the increasing speed of information and business processes fostered by information and communication technologies. Technical support not only for information storage and retrieval but also for information selection, process planning, and decision support is needed. Moreover, the use of a (desktop) computer is restricted in many ways. In this paper, it is predicted that smart and mobile computing units embedded in a variety of things, such as TV sets and cars, will bring computing power close to their users. It is also predicted that users will get closer to computing power by using natural language and by using their social skills in computer mediated communication. A holistic architecture of knowledge robots (knowbots) is described based on multi-agent platforms and distributed computational intelligence. Knowbots consist of a self-learning artificial brain, speech recognition and synthesis, direct access to other software agents and computer programs, and direct connections to networks of human users. It is pointed out that a newly defined partnership between men and machine is a possible way to keep control of the exploding 'infoverse'.

Reasoning and simulation mechanisms of currently unthinkable complexity will take over the control of process planning and information exchange. Fourth generation robots with the capability of performing more than 30 million instructions per seconds (MIPS) will be the heart of a company's knowledge base. This is the vision propagated by Hans Moravec, Principal Research Scientist at the Robotics Institute and Director of the Mobile Robot Laboratory of Carnegie Mellon University, Pittsburgh (USA).

The global economy gets accustomed to the idea of the 'new economy' where the knowledge workers' creativity and skills are the companies' most important capital and competitive advantage. If only parts of Moravec's vision come true, however, it will certainly mean that the relevance of human expertise and experience will diminish. Current developments seem to support this point of view: A supplier of computer storage systems reports that especially banks are consuming more storage space within six months than has been used during the last twenty years; the increasing speed of product innovation and life cycles depreciate technological knowledge and skills within one to three years.

The 'infoverse' stored in the worldwide Internet starts to exceed the amount of information that has been stored in more than 60,000 years of human culture before: It has been estimated that in the years 1972 to 1980 more information has been collected than in the 2000 years before. Fifty years after the publication of the first Gutenberg bible about two million books had been published; today, more than 3000 books are published per day, more than one million per year. Some authors, therefore, are discussing the advent of the 'age of knowledge'. Others, however, argue that the Internet is not more than a gigantic heap of information garbage.

Recent studies show that we are not able to remember more than one to two percent of all the information we perceive in the mass media, such as radio, TV, or newspapers. A single search engine covers not more than about twenty to thirty percent of the World Wide Web pages, meta-search services using more than one search engine comprise about fifty to sixty percent of the WWW pages. Even the best text searching and indexing techniques do not come up with more than 25 percent of relevant links or search results, that is, an optimal search process accesses a quarter of a half of the information in the Internet - and one or two percent of this information can be remembered. Thus, we have to state that we have lost control over all the information gathered in technical systems.

Exponential growth of information, information access at light speed and the increasing speed of business processes and the decreasing value of human knowledge force to re-focus the development of information and communication technologies (ICT). Information accessibility is no longer the main concern, but navigation, orientation and selection of relevant information. As computers and robots provide us with incredible capabilities to process increasing amounts of data within decreasing periods of time, it seems clear that we can only master the self-made 'information overload' if we manage to enhance our skills by developing a real computer-man dialogue and partnership.

The key topics of this new level of CMC (computer-man communication) is a mobile, ubiquitous and selective information access enabled by smart software agents based on multi-agent platforms using distributed computational intelligence. We are now at a turning point in our cultural development where sustainable progresses can only be made if we are able to delegate information retrieval, process planning and decision support to technical systems. We have to decide whether we want to become garbage collectors within heaps of information - or the human masters of smart agent systems which we do not fully understand.

If it works, it's not AI

Up to now, the progresses of the so-called Artificial Intelligence (AI) have been disappointing. A recent study about the commercial success of AI startup companies comes to the conclusion: 'If it works, it's not AI'. This assumption has been reflected in the revenues of AI corporations during the last decades (cf. figure 1). The strong position of AI is to develop machines that are intelligent in a human way. The weak position of AI is to implement programs that can be viewed as 'partly intelligent' because they are able to perform actions that used to be dedicated to human workers. This mode of AI is now referred to as 'Computational Intelligence' (CI). Patricia Churchland pointed out that we are at a stage where the strong AI position tries to mimic human intelligence in the same way the first pioneers of flight tried to mimic the birds' way of flying. As no modern airplane or helicopter is flapping its wings, it is clear that solutions enabling flight are not relying on flapping wings but on a proper lift. So, what might be a way to lift the weak position of AI to a higher level?

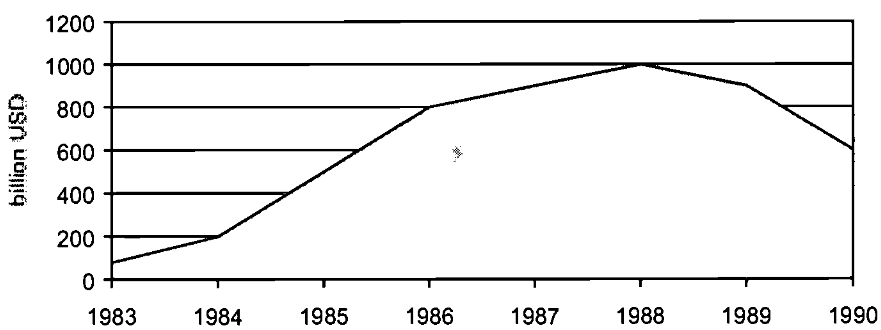

Figure 1: Approximate AI revenues (Philipps, MIT, 1999).

In 1998, the non-profit association 'Institute of New Media' and Bank Academy, a non-profit educational institution of the German bank associations, formed a joint venture to implement and test new ways of autonomous software agents which could help learners and knowledge workers in information intensive industries, such as banking and finance. At the beginning of the year 2000, Knowbotic Systems Inc. Ltd. was founded by the Institute and the Bank Academy. The purpose of this company is to develop and to examine knowledge robots or 'knowbots' which help to fully exploit the knowledge capital of a company by facilitating information selection, planning and decision making. The mission of Knowbotic Systems relies on two basic assumptions: (1) As long as key concepts, such as 'learning' and 'intelligence', are not fully understood and clearly defined, computers won't be intelligent learners. Therefore, a formal learning theory has to bc deduced from recent theories and empirical studies in order to set up a virtual testing environment for knowbots which helps to measure their adaptability and to extend their learning capabilities. (2) The critical lift of CI will not come if a system is intelligent in itself, but it comes from the human capability to communicate with such a system in a intelligent and social way. Thus, knowbots have to mimic intelligent communication behavior in order to transfer the results of machine learning and machine reasoning to human users (cf. figure 2).

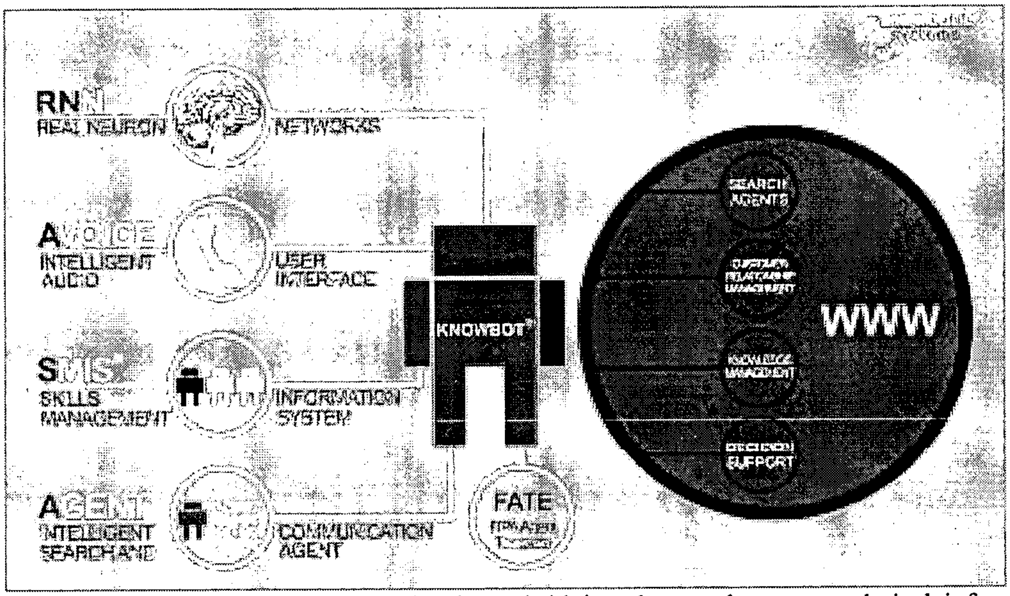

Figure 2: Knowledge robots (knowbots) are bridging the gap between technical information and data collections (right) by using artificial brains (RNN), ears and voice (AVOICE) and connecting information (AGENT) and people (SMIS) based on the multi-agent platform FATE.

The artificial brain

Most programs which mimic intelligent behavior are based on logical oriented knowledge-based techniques which proved to be too inflexible to represent even primitive forms of learning. Moreover, they elicit a number of paradox behavior when applied to support human learning. In classical AI different forms of logical based representational schemes are used and in connectionism researchers adhere to different types of artificial neural networks (ANN). ANNs have achieved some success in non-linear forecasting, pattern matching and in artificial life paradigms. But ANNs still lack many of the vital features of biological neural networks (BNN), such as the ability of real neurons to allow self-modification with regard to short term and long term learning. The simulation of BNNs developed by neurobiologists does not seem to be promising either because recent attempts have shown that exact simulations of neuron brain cells consume a vast amount of computer resources. For instance, 18 hours of computing time on five connected Sun Sparc workstations is needed to simulate one second of the activity of a single neuron.

Knowbotic Systems combines the behavioral perspective with the physiological perspective, both embedded in concepts of learning and sign based communications (or Semiotics). We call these self learning and sign-using systems 'knowbots'. The physiological structure is the main cause for observable behavior. Thus, we have to find a model of the human brain neuron which should be empirically more sound than the classical ANNs and should also be still practically feasible on 'ordinary' PCs. Knowbotic Systems' RealNeurons® almost perfectly simulate human brain cells with respect to the height of the potentials, the timing of the processes and the concentrations of chemical substances involved. Moreover, our neural networks can model the local and global influence of hormones and psycho-pharmaceutics on brain cells. We are modeling only those properties of biological cells which are most likely underlying learning of new behavior patterns.

Only a few BNNs underlying learning, however, have been identified yet. As a first test case we have chosen a classical conditioning circuit and several candidates that might be responsible for operant conditioning. In first experiments we implemented the network which represents the eye blink reflex of a rabbit. The network matches the neuropsychological data almost perfectly (cf. figure 3): The connection of the unconditioned stimulus (US = air flow) and the conditioned stimulus (CS = sound) is learned in a few trials, if the CS is given slightly before the US. Several runs presenting the CS without the US extinguish the connection. It is re-established very quickly, if the CS and the US are displayed together again. This means, that not only the neuro-biological structure of brain cells can be simulated on a PC, but also basic learning behavior which perfectly matches empirical data.

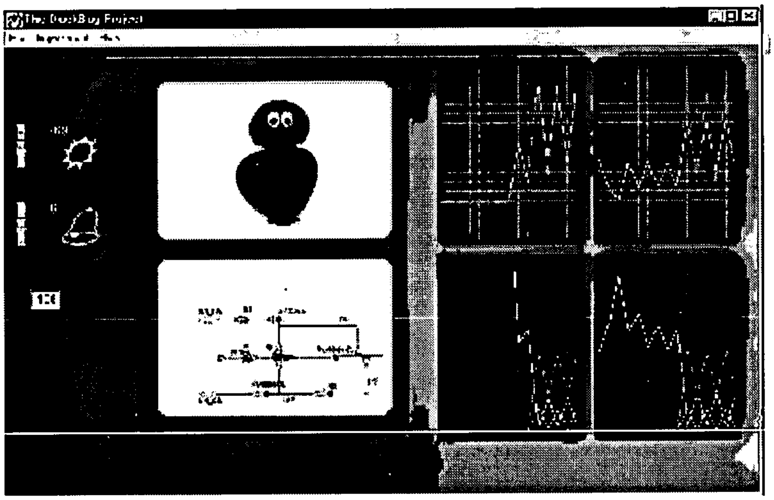

Figure 3: Test environment for (classical and operant) conditioning experiments with Knowbots based on artificial biological neural networks implemented with Java.

The artificial body

The artificial brain cannot communicate to humans and environments without a body. Robotics' research has shown that intelligent or adaptive behavior is based on a close interaction with the outside world. Moreover, the measure of learning or intelligence clearly depends on observable behavior corresponding to well defined learning tasks and environments. Knowbotic Systems, therefore, concentrates its technical developments on interface technologies which facilitate the access to knowbots by human users. The most important way to communication is speech. Knowbots are equipped with the speech recognition and synthesis system *AVOICE*. The speaker independent speech recognition is able to identify about fifty words in five different languages at a time. As the word recognition can be adapted according to the actual context, this small amount of words is sufficient to implement small navigational or command systems. The speech recognition unit may also be trained to understand a specific user and it is then capable to handle dictionaries of several hundreds or thousands of words. The speech synthesis can read any text, such as HTML pages, tables or documents. The user can choose between several 'speakers' with different pronunciation or intonation. In summary, AVOICE equips knowbots with a - still limited - human ear and voice. Knowbots, therefore, connect their users directly to all the information stored in the Internet, regardless whether they hook onto the Internet via a computer, a telephone, or a mobile phone.

Knowbots can also move around in the Internet, access data bases and organize their user dialogues. This is done by *AGENT*, an intelligent search agent and dialogue manager. The search agent is able to act as a search robot and a crawler in the World Wide Web. It can also get access to data bases or transform graphical information into text information. Thus, AGENT provides knowbots with a variety of ways to 'perceive' the virtual infoverse of the Internet.

The artificial environment

Up to now, there is much more talking about the irreplaceable value of the human capital and knowledge than taking actions to maintain and support the development of this capital. Most technical systems concerning the human capital of a company focus on the administration of personnel and training, such as SAP Human Resource modules, Peoplesoft or SABA - just to mention a view of them. An US-American study lists about 300 systems for training administration and delivery. But finding matches of needs and demands in the infoverse certainly means more than matching keywords to indices or user profiles to software agents. The knowledge economy is not so much about information, it is about people. Knowbotic System is, therefore, engaged in a jointly initiative of several partners to implement a Skills Management Information System called 'SMIS'.

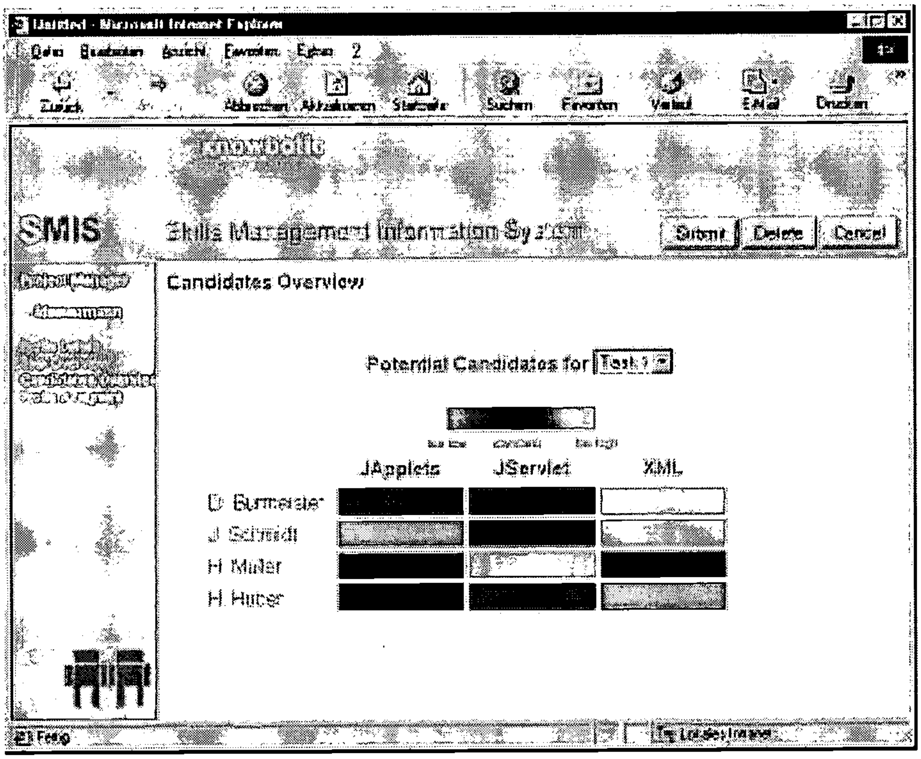

Figure 4: Screen shot from the Skills Management Information System 'SMIS' - the candidates overview lists possible candidates for a project tasks in acolored table indicating skills below or above the standard.

Human users, the users of information systems, visitors and creators of the infoverse, are the main 'component' of a knowbot's environment. Additionally, other knowbots or standardized software agents may also enrich the knowbot environment. For this purpose, Knowbotic Systems has developed one of three worldwide available multi-agent platforms based on the FIPA standard (FIPA = Foundation of Intelligent Physical Agents). The platform *FATE* (FIPA Agent Template) comprises templates or suits which allow programmers to convert nearly any computer program into a software agent, that is, the knowbot technology provides easy-to-use ways to introduce a large variety of programs into the virtual learning environment. FATE also allows to run several platforms on different Web sites. This enables knowbots and other agents to communicate, move or replicate themselves all over the World Wide Web.

The (artificial) future

We envision future developments in networked computing and distributed computational intelligence where the users are no longer forced to adapt to the computer. The computers will adapt to the human capabilities to perceive and process data. The communication between and with computers will adapt to the human way of communication, namely natural language. And computers will be accessible at any time from any point with any device, such as handhelds, laptops, or mobile phones. Computer networks will also become people networks, taking into account specific deficits and potentials of computers and humans.

Knowbots are one of the few holistic visions of a man-machine dialogue in its actual sense, dedicated to support humans where they need help to access and select information - and to learn from them. But knowbots are not the only development in this field. A new level of smart agents and self-learning machines will develop in the near future. Figure 5 summarizes some major developments which are expected in the near future. Among them are software agents, mobile computing, and speech control. But, most of the forecasts of technological growth and development turned out to be too conservative.

2004	2005	2006	2007	2008	2009	2010
Ubiquitous online learning in universities	Online learning in schools (K12) Interactive communities in the WWW Increasing use of eCommerce	Software agents to search and select information Interactive TV for big audiences	Increasing use of speech recognition and synthesis Central remote control station for 'intelligent buildings'	Increasing use of electronic cash Broadband access to information	Mobile computing and eCommerce	Self-learning software agents 3D virtual reality

Figure 5: Some major developments in interactive media in the next ten years according to a recent study of the Fraunhofer Gesellschaft (Institut für Systemtechnik & Innovationsforschung).

Up to now, many individuals and companies are fascinated by the potentials and the exponential growth of the Internet. We do not think that future generations will be too enthusiastic about slow networks, unstructured information heaps and poorly equipped online shopping malls. Smart computers will be part of our every-day life, will be part of houses, cars, TV sets, refrigerators, bags, and suits. As a matter of fact, many ordinary machines are based on so-called embedded systems, that is, a small specialized computer. So, the things start to become computational things - and they will be smart things in the future. Knowbots and other smart agent technologies will support work, leisure and even cultural or social entertainment. Computers in the form of smart things will make computational intelligence as ordinary as cars or TV sets. But if the computers get nearer to their users, at the same pace the humans will get nearer to the computers: Not individual human beings nor software agent platforms will be the masters of the infoverse, but partnerships of robots, knowbots, and humans.

References

Doeben-Henisch, G. (1998b). Semiotic machines - an Introduction. In E. W. B. Luettich, J. E. Mueller & A. van Zoest (Eds.), Signs & space, Raum & Zeichen. An international conference on the semiotics of space and culture (pp. 313-327). Tübingen: Gunter Narr.

Goddard, N. & Hood, N. (1997) Parallel GENESIS for large scale modeling. In J. M. Bower (Ed.), Computational Neuroscience '96. New York: Plenum.

Harasim, L. M., Hiltz, S. R., Teles, L. & Turoff, M. (Ed.)(1995). Learning Networks : A Field Guide to Teaching and Learning Online. Boston: MIT Press.

Hasebrook, J. (1995a). Lernen mit Multimedia (Learning with multimedia). German Journal of Educational Psychology, 9(2), 95-103.

Hasebrook, J., & Nathusius, W. (1997). An expert advisor for vocational guidance. Journal of Artificial Intelligence in Education. 8(1), 21-41.

Maass, W. (1997). Networks of Spiking Neurons: The Third Generation of Neural Network Models. Graz: Institute for Theoretical Computer Science, TU Graz.

Moravec, H. (1998). When will computer hardware match the human brain? Journal of Transhumanism (1).

Sheperd, G. M. (Ed)(1998). The synaptic organization of the brain. Oxford, New York: Oxford University Press.

Sproull, L. & Kiesler, S. (1991). Connections: New ways of working in the networked organization. Cambridge, MA: MIT Press.

Learning on the Internet: Taking the ecology metaphor further[1]

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The Internet is a powerful phenomenon that is radically transforming many of our cconomy, politics, culture, education, business and social processes, and almost everything else. In order to make sense of such a phenomenon, researchers have applied the ecology metaphor to information production and consumption on the Internet. In the education and training arena, some authors and researchers have also applied the ecology metaphor to viewing learning on the Internet (Brown, 1999). The Internet is seen as a powerful medium for creating and supporting a learning ecology. In this paper, we explore the notion of a learning ecology on the Internet by looking at the dimensions of diverse participation, information production and consumption, representations and experiences. We hope such a discussion would be useful in framing some of the educational technology problems and solutions on the Internet as well as deriving implications for designing tools and learning activity structures for online learning.

1 Introduction

Metaphors serve as a kind of mirror that brings out illuminating aspects of the phenomenon we are trying to understand. Lakoff and Johnson (1980) say that metaphors are pervasive because they reflect how we think, and, when we change the metaphor, we change the way we think about things. Stefik (1997) writes that the policies that shape the design and use of the Internet are often influenced by the metaphors that we ascribe to it. The most common metaphor of the Internet is the information superhighway. The metaphor for the digital library on the Internet is a publishing and community memory; the metaphor for the electronic marketplace is a place for buying and selling goods and services; and the metaphor for the digital worlds is a gateway to experience (Stefik, 1997).

In this paper, we examine the phenomenon of learning on the Internet in terms of a digital ecology. What does such a learning ecology metaphor buy us? How does it help us to recast or reframe some of the classical problems of education and distance learning in quite new terms (Brown, 1999)? We would expect a learning ecology metaphor to allow us to see things from a systemic perspective, and understand the components of the system and how they interplay with each other to enable and to support the processes of learning.

We posit that an ecological perspective is consistent with the perspective of distributed cognition. By viewing cognition as fundamentally distributed rather than residing "in the head", in a classroom situation, the tools, the rules, values and actors in a classroom form a highly complex, interacting system (Hewitt & Scardamalia, 1997). Knowledge is distributed among different people and mediated by tools and artifacts in the environment. An ecological perspective emphasizes the relationships and dynamics between the various participants in the classroom or in any learning situation.

[1] This paper is a revised copy of the paper that appeared in Educational Technology, May-June 2000.

2 Ecology of Diverse Participation

The Internet has properties that make for an open ecology. It is diverse, dynamic, self-organizing, self-regulating, inter-dependent, and removes boundaries. Brown (1999) states: "An ecology is basically an open, adaptive system comprising elements that are dynamic and interdependent. One of the things that makes an ecology so powerful and adaptable to new contexts is its diversity." Maes (1999) describes a digital ecology as a collection of people and machines that perform activities in a distributed way. It is adaptive in that none of the components is critical: even if some people and machine are removed, the system will still perform.

The Internet as a digital ecology provides new solution paths to problems. Brown (1999) describes it as small efforts by many people and machines to solve problems, rather than large efforts by the few. In his aggregate analyses of participation in discussion forums and newsgroups, Guzdial (1997) observes that few students contribute many notes to the conversations, and many students contribute few notes to the conversation.

Diversity of participation provides efficient, adaptive and robust way of doing things. Within the walls of a classroom, the student is limited in his interactions with the other participants, the teacher and other students. When the students are connected online through the WWW, she has access to diverse sources of information and expertise. The learning tasks for the students become one of knowing how to look for relevant information and knowledge, how to evaluate, assimilate, synthesize and apply them, and how to work with others to achieve their goals. When we view learning from a systemic perspective, we consider all the diverse participants – students, teachers, parents, the principal, education officers, colleges, universities, libraries, organizations, etc.

In recent years, many researchers and practitioners have viewed learning as a process in which learners construct knowledge and negotiate meanings together. Learning is seen from the perspective of participating in a "knowledge-building community" (Scardamalia & Bereiter, 1994), a "community of practice" (Lave & Wenger, 1991), or "community of learners" (Brown, 1992). In such communities, learning is an "intermental process" (Vygotsky, 1978; Edwards & Mercer, 1989; Morrison & Collins, 1995) that takes place in the context of real-time discourse. Knowledge internalization occurs when this interpersonal process at the social level is transformed into an intrapersonal process at the individual level. The Internet provides the technology infrastructure for enabling many interpersonal and social processes that were not possible or even imagined before.

Online communities are the herds that have a current standing common area of interest. Myriads of communities thrive on the WWW. There are collections of communities with overlapping interest, and cross-pollinating each other (Brown, 1999). Communities evolve and self-organize on the WWW. Designers of educational technologies need to think of the mechanisms to help such cross-pollination and to help sustain and grow good communities for learning.

In biological evolution, there is a major pattern of speciation. In speciation, the original species splits into more than one descendant species, each adapted to a different niche. Niche is a term in ecology which means the place occupied by a species in its ecosystem, or the potential place or role within a given ecosystem into which a species may or may not have evolved. The notion of niches maps to the communities of interest on the Internet. If the community is too narrowly defined, it may risk extinction as its niche disappears. The larger, the more varied (resulting in diversity of contributions), and more flexible a population, the greater its ability to spread to new niches. Here is the notion of communities of interest splitting and specializing into different niches.

The survival of population is defined as the continuation of its genetic code. The analogy for a learning community is for its knowledge base, tools, approaches, practices, and values to continue in some form. Online communities are a means to help preserve and continue the interests, knowledge and culture of a group bound by common interests.

Different parts of the ecology coevolve, changing together according to the relationships in the system (Nardi & O'Day, 1999). As people participate in the ongoing development of their ecologies on the Internet, they drive some of the technological and social aspects in the evolution of the Internet. The participants of a learning ecology are responsible for deciding how to use the tools and technologies available on the Internet, and in doing so, establish the identity and place of the technologies on the Internet. Designers of tools on the

Internet are responsible for providing useful and clear functionality, but they do not complete the job (Nardi & O'Day, 1999). It is left to the users of these tools to integrate them into their own context of use that make sense for them. Learning ecologies provide the context of use of tools as well as content available on the Internet.

3 Ecology of Information Production, Access and Consumption

Aggregate behaviour within an information space such as the WWW is seen an "information ecology" (Card, Robertson & York, 1996). The participants in such an information ecology are the producers, gatherers, and consumers of information. We study the rules of behavior and the relationships between variables in the information ecology to learn how to maximize the ecology, for example, by gathering more information at lower cost (Guzdial, 1997). Ecological models of the WWW are being developed, for example, that describe when pages are created or deleted, and when they are accessed (Pitkow & Pirolli, 1997). When information is accessed or consumed by participants for the purpose of learning or knowledge advancement or performing or acting upon, the information ecology becomes a learning ecology.

Ecological theory focuses on populations, not individuals, and on the dynamics of the relationship between populations and environment. A ecological system has variables $\{x,y,z,\ldots\}$, relationships $\{a(x+z), \ldots\}$ and dynamics such as attractors and manifolds. If we look at the Internet as an ecology, then in terms of variables, we understand that anyone can become an author, and contribute content to the WWW. This may take the form of sending emails, creating and uploading web pages, contributing to discussion groups or chat forums, participating in communities of interest, and others. Relationships comprise the links, relevance evaluation, aggregation, and search, which relate the contents created by authors. Authors of content can create the linkages from their content to other content, for example, web pages can be linked to other web pages, and messages may contain URLs. Such web content may be rated with relevance ratings, and catalogues of web content can be created such as Yahoo.com. Once the web content is on the WWW, search engines will be able to index such content and include them in future searches.

The dynamics comprises content design and delivery mechanisms. Good content or designs are copied instantaneously, or at the upper end - at the speed of light. The Internet as a medium makes this possible. Contrast this with the print medium where information transfer is several orders of magnitude slower. Once content is posted or uploaded to the WWW, the gatherers and consumers of the content can access them immediately. And of course, on the Internet, digital content feeds many unlike in physical ecological systems. The exponential growth of the WWW is expedited by the increasing availability of delivery mechanisms, which make it easy for anyone to be a producer of content. Delivery mechanisms includes free hosting services for websites, email accounts, personal organizers, groups, etc.

One attempt to maximizing the ecology is the effort to develop software application frameworks and approaches to enable true interoperability of learning systems on the Internet. The perspective is not to see learning systems functioning as an independent island among an ever increasing base of online learning content and service providers, partners, suppliers and competitors (Singh, 2000). There is a need to move from creating and delivering large training courses toward creating learning content objects that can be reused, searched and modified independent of their delivery mechanism. A growing consensus is growing around an object-based approach to constructing content for online delivery. The concept is based on chunking content into reusable components and developing methods to create instructional sequences. Such "componentization" of the content provides several benefits: from the development perspective, reusability decreases the time and cost of content development; from the delivery perspective, a higher level of individualization is possible by "late binding" or personalization of curriculum with individual needs and interest (Singh, 2000). Technologies like XML (Extended Markup Language), a standard format for Internet data information exchange, make possible the meta-data tagging of content objects. If a planned or de facto standard indeed arises for reusable educational objects, products and services will grow to harness such opportunities. This will stimulate substantial growth in the use of the Internet for delivering learning.

From another perspective, if we view learning as knowledge advancement, learning is a form of intellectual foraging. Learners forage for "food" on the Internet. This metaphorical food suggests good information, data and knowledge, which can promote learning. Some consume good knowledge and produce better knowledge. Others consume bad knowledge and suffer ... Can we extend the analogy further? How do foragers learn what are good and bad food? How do foragers pass this knowledge on to other members of their clan? Herein lie opportunities for designing and using technologies and tools to provide such mechanisms to support this process and improve the ecological balance. For example, while paper publishing is a one-way medium, the web is different. A consumer of web content can invariably tell the author of the contents what he thought.

Ecological systems exhibit the herd principle: when searching for sustenance, follow the track of others. Recent work has looked into the capture of the interaction history and the notion that the work done by past users can be important to helping current users solve problems such as navigation in a complex information space. For example, map and trail mechanisms are created on top of hypertext systems or WWW by designers for guidance or pedagogical purposes. They include: Scripted Documents, which are top-down created artifacts to assist in navigation (Zellweger, 1989); WebWatcher, a tour-guide agent for the Web (Joachims, Freitag & Mitchell, 1997), and Walden's Paths, a K-12 educational application of scripted paths (Furuta et al, 1997).

Metadocuments are higher-level structures that link information related by topic or interest. Tools based on this concept include IBM's Aqui (http://www.aqui.ibm.org), Web rings (http://www.webring.org), and Footprints (Wexelblat & Maes, 1999). Recent developments have now enabled any user, not just the designer, to script and create these map and trail mechanisms (see, for example, Third Voice at http://www.thirdvoice.com).

A personification of a natural law is "Nature abhors a vacuum." Would it be the same on the Internet? Any published content on the Web would like to draw a ready audience but it is not always the case unless the content is linked from existing web resources, and there are easy and effective ways of accessing the content. A discussion forum or a chat tool open to the public can draw some form of participation but the organizer of such forums would like to draw productive participation instead of nominal or frivolous participation. "Build it and they will come" is a philosophy that will not work for attracting traffic to your contents or portal or learning community unless there are strategies in attracting traffic and bringing them back again (Hagel & Armstrong, 1997).

4 Ecology of Representations

An ecology has diversity through its participants. This provides resilience and feedback on the contributions made by any participant. We now discuss the notion of diversity now just from participants but by the representational forms of knowledge. Many representational forms can be used for learning on the Internet thus creating a kind of ecology of representations.

Looking at the Internet as a learning ecology in terms of representations, the variables are the representations freely available to all users. Relationships comprise the various design patterns for content creation. The dynamics involves leveraging on the combinations of representations to deliver the messages.

The Internet, as a new medium for learning, is the first medium that respects multiple forms of intelligence: textual, visual, abstract, musical, social and kinesthetic (Brown, 1999). There is now a plethora of media now available on the Internet: streamed video, images, and text that provide multiple ways of expressing ourselves. There are effective ways in which these different media augment each other. A representational learning ecology, populated by many different representational kinds including visual and verbal ones, respects multiple forms of intelligence. For example, there is a place for text verbal representation, as witness the success of many text-based MUDs and MOOs in supporting communities of learning.

The medium plays an important role in terms of the affordances for visual and verbal representation. An audio stream provides for a linear exposition, while a text stream allows for more introspective reading where you can go back to previous portions of the text. Video by itself is a visual medium, but it does not provide for active engagement and interactivity. The development of Internet technologies has shifted heavy use of verbal representations on the Internet (initially with text, and later graphics and voice) to more visual representations (videos, etc). Visual and verbal representations augment each other. We can use verbal text tools to annotate not just web pages, but visual streamed media. In this way, visual tools provide the richness of context, while textual tools allow the formulation of discourse, which focuses on particular aspects of the context. Conversely, visual tools are often used to animate or depict what the participant wants to communicate (as researchers, we would grab the nearest napkin to illustrate our ideas quickly). Augmenting representations through annotations add more context to the main representation or message.

One of the effective ways of fostering learning is by fostering conversation. A learning conversation is more likely to revolve round a co-production of an insight around a joint activity (Brown, 1998). On the Internet, we can use or design tools to support these joint activities. Conversation is not just language, but also multimodal and multimedia in form. Visual tools for representation expand the range of representations beyond *linear* speech & writing, and support the creation of knowledge *in situ*. On the Web as a learning platform, verbal tools leverage on our capacity for conversation while visual tools provide a focus for conversation.

A diversity of different representation forms is now possible in the new learning ecology. The coupling of different representations in innovative ways allows the creation, capture and sharing of knowledge that supports effective learning, and respects multiple ways of knowing and multiple intelligences. We can now present multiple perspectives of a phenomenon, and we can build and provide rich representations of situations, simulations and phenomenon.

Consequently, we propose the law of foraging for optimal representations: the forager is attracted to the representation that provides the highest information yield at the lowest access cost. The advent and pervasiveness of portable devices make possible information access at any time. With the right bandwidth and at the right cost, you can have rich representations such as video and other complex media. With lower bandwidths and at lower cost, you can get a digest or summary or surrogate version of richer representations. Herein lie opportunities for adapting presentations to suit the bandwidth, the display device, the cost and the type of consumer. Content sites are offering their own products, such as quick updates beamed to small handheld computers and cell phone screens and subscriptions to longer versions of articles and other features.

5 Ecology of Experiences

A more recent model of the Internet is Pine and Gilmore's notion that we have moved beyond a service economy to an "experience" economy (Pine & Gilmore 1999). In the business sector, all business must orchestrate memorable events for their customers. Pine and Gilmore explain the difference between service and experience: "When a person buys a service, he purchases a set of intangible activities carried out on his behalf. But when he buys an experience, he pays to spend time enjoying a series of memorable events that a company stages – as in theatrical play – to engage him in a personal way". Pine and Gilmore argues that for any compelling experience, there should be elements of entertainment, educational, esthetic and escapist, the design of which would invite participants to enter and to return again and again. As McLellan (1999) observes, Pine and Gilmore's model of the experience economy provides an excellent starting place for educational institutions to plan how to capitalize upon their valuable experience assets in cyberspace.

We look at a learning ecology in terms of the providers of education experiences, the space and the props, and the consumers of the experiences. If we think about providing educational experiences on the Internet, we need to think about the design of the entertainment, educational, esthetic and escapist elements (McLellan, 1999). McLellan notes that organizations like PlanetAll (http://www.planetall.com) seek to capitalize on the lasting experience value of higher education in cyberspace by helping alumni network with each other and shared continued experiences such as travel and enrichment opportunities.

Digital stories is another compelling metaphor for the experience economy (Atchley, 1999). It involves the gathering, creation, sharing and acting out stories. The learning ecology involves the provision of tools for authors to create the space, props and stories, and the provision of the space for participants to actively participate and immerse into the digital stories.

6 Conclusion

The ecology metaphor helps us understand the phenomenal growth of the web as well as its dynamics. Applying the ecology metaphor to learning on the Internet is a complex endeavour. It is more than an information ecology as the chain does not stop when the user accesses and receives relevant information. We also need to consider whether learning occurs, what and how is being learned, and how information and knowledge are processed, used, applied and internalized in the user.

In this article, we articulate the dimensions of diverse participation, information production and consumption, representations and experiences that pertain to a learning ecology on the Internet. An ecology perspective to studying Internet learning enables analysis at a high level of abstraction by studying aggregate relationships and behaviours. Such an understanding can suggest successful learning designs, and to inform designs of technologies and tools for online learning.

As the WWW expands, and Internet technologies and services develop and proliferate, new theories of information and learning ecologies can be expected to develop. As we further understand the learning ecologies of the Internet, we can better design and use these facilities in order to facilitate learning, and to help design activities and tools that foster learning communities as learning ecologies.

References

[1] Atchley, D. (1999). Digital storytelling. Presentation at the Consumer Electronics Show, Las Vegas, as quoted by McLellan (1999).

[2] Beer, M. (1999, Dec. 12), Content makes comeback on Web, *San Francisco Examiner*.

[3] Brown, A.L. (1992), Design Experiments: Theoretical and Methodological Challenges in Creating Complex Interventions in Classroom Settings, *Journal of the Learning Sciences*, 2(2), pp. 141-178.

[4] Brown, J.S.B. (1998), Leveraging the Web For Creating Learning Ecologies, keynote talk at International Conference on Computers in Education, Beijing, China, http://www.apc.src.ncu.edu.tw/apc/ppt.html.

[5] Brown, J.S.B. (1999), Learning, Working & Playing in the Digital Edge, Address to the AAHE 1999 Conference on Higher Education.

[6] Card, S. K., Robertson, G. G., & York, W. (1996). The WebBook and the Web Forager: An information workspace for the World-Wide Web. In M. J. Tauber (Ed.), *CHI96 Conference Proceedings* (pp. 111-117). Vancouver, BC: ACM.

[7] Conklin, J., Ellis, C., Offermann, L., Poltrock, S., Selvin, A. and Grudin, J. (1998), Towards an Ecological Theory of Sustainable Knowledge Networks, http://www.gdss.com/ecology.html.

[8] Davis, J. R., & Huttenlocher, D. P. (1995). Shared Annotation for Cooperative Learning. In J. L. Schnase & E. L. Cunnius (Eds.), *CSCL '95 Proceedings* (pp. 84-88). Bloomington, IN: Lawrence Erlbaum and Associates.

[9] Edwards, D. & Mercer, N. (1994), Reconstructing Context: The Conventionalization of Classroom Knowledge, *Discourse Processes,* 12, 91-104.

[10] Furuta, et al. (1997), Hyptertext Paths and the WWW: Experiences with Walden's Paths, Proceedings of the 8th ACM Conference. New York ACM Press.

[11] Guzdial, M. (1997), Information Ecology of Collaborations in Educational Settings: Influence of Tool, http://guzdial.cc.gatech.edu/papers/infoecol.

[12] Hagel, J. & Armstrong, A.G. (1997), *Net Gain: Expanding Markets through Virtual Communities*. Cambridge, MA: Harvard Business School Press.

[13] Hewitt, J. & Scardamalia, M. (1997), Design Principles for the Support of Distributed Processes, http://csile.oise.utoronto.ca/abstracts/distributed.

[14] Joachims, F. & Mitchell (1997), WebWatcher: A Tour Guide for the WWW, *Proceedings of IJCAI 97.*

[15] Lakoff, G. & Johnson, M. (1980), *Metaphors We Live By*, Chicago: University of Chicago Press.

[16] Lave, J. & Wenger, E. (1991), *Situated Learning: Legitimate Peripheral Participation*, Cambridge: Cambridge University Press.

[17] Maes, P. (1999), Very Personal Computers, in Peter J. Denning (ed), *Talking back to the machine: Computers and Human Inspiration*, Copernicus, New York: Springer-Verlag.

[18] McLellan, H. (1999), Online Education as Interactive Experience: Some Guiding Models. *Educational Technology*, September-October 1999, pp. 36-42.

[19] Morrison, D. & Collins, A. (1995), Epistemic Fluency and Constructivist Learning Environments, *Educational Technology*, 35(5), 39-45, reprinted in B.G. Wilson (ed) Constructivist learning environments. Englewood Cliffs NJ: Educational Technology Publications.

[20] Nardi, B.A. & O'Day, V.L. (1999), *Information Ecologies, Using Technology with Heart*, MIT Press.

[21] Pine, A.J. & Gilmore, J.H. (1999), *The experience economy: Work is theatre and every business is a stage.* Cambridge, MA: Harvard Business School Press.

[22] Pitkow, J., & Pirolli, P. (1997), Life, Death, and Lawfulness on the Electronic Frontier. In S. Pemberton (Ed.), *CHI97 Conference Proceedings* (pp. 383-390). Atlanta, GA: ACM.
[23] Scardamalia, M. & Bereiter, C. (1994), Higher Levels of Agency for Children in Knowledge-Building: A Challenge for the Design of New Knowledge Media, *Journal of the Learning Sciences,* 3(3), 265-284.
[24] Singh, H. (2000), Achieving Interoperability in e-Learning, ASTD Learning Circuits, March 2000, http://www.learningcircuits.com/mar200/singh.html.
[25] Stefik, M. (1997), *Internet Dreams – Archetypes, Myths and Metaphors*, Cambridge, MA: MIT Press.
[26] Vygotsky, L.S. (1978), *Mind in Society: the development of higher psychological processes*, Harvard University Press, London.
[27] Wexelblat, A. & Maes, P. (1999), Footprints: History-Rich Tools for Information Foraging, CMI '99 Conference Proceedings, New York: ACM Press.
[28] Zellweger, P. (1989), Scripted Documents: A Hypermedia Path Mechanism, Proceedings of the 2nd ACM Conference on Hypertext, New York: ACM Press.

What can we Learn from the Systems we Build? From Providing Support to Students to Providing Support to Teachers

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Computer scientists involved in the field of learning systems must study the implications within individual and social behaviors of theoretical and technical advances. In particular, integrating learning systems within real classes supposes their acceptation by the social context, i.e. not only the students, but also the "human" teachers. We will present two research projects of the LIUM lab. that correspond to very different approaches of constructing learning systems and we will study what the teachers' role is within these types of systems. We will investigate how these systems are viewed by human teachers and discuss what lessons can be learned from these projects in order to facilitate the acceptation of new technologies within the social context. We will underline that while working on how to construct apprenticeship situations, a large part of our research work focuses in fact on instrumentalizing human teachers' (new) activities and providing these teachers with some support, and we will highlight how this point finds some echo within the current debates that the up-coming revolution introduced by Internet causes in traditional educational structures.

Foreword

Certain occasions give the opportunity of looking back and attempting to understand what we have done and what we are doing in order to decide where we should go. The LIUM lab (Laboratoire d' Informatique de l' Université du Mans – computer science lab of the Mans University), well known French laboratory with a fifteen years experience in developing state-of-the-art learning systems, has a sad occasion to analyze its activities: the tragic disappearance of Martial Vivet, founder and scientific leader of the lab. This paper has been written in this context and is dedicated to Martial. However, the point-of-view is that of the authors.

1 Introduction

Martial Vivet and LIUM' s credo is that computer research and educational research can and must progress together by focusing on apprenticeship with technical features. Artificial Intelligence and new technologies modify student-teachers relations. Research must be student-centered and not technology-centered and computer scientists involved in the field must study the implications within individual and social behaviors of theoretical and technical advances.

As a direct consequence, constructing Intelligent Tutoring Systems seen as a paradigm whose ultimate objective is to replace human teachers by intelligent software agents is not our objective. As other labs, we were confronted with the intrinsic difficulties of constructing such systems, i.e. dealing with curricula, pedagogic knowledge, students' models, etc. However, working "in the field" and experimenting our prototypes with real students and real teachers gave the major reason: integrating such systems within real classes supposes their acceptation by the social context, i.e. not only the students, but also the "human" teachers. Therefore, most of the lab work focuses on using technology as a support to construct apprenticeship situations that the teachers can deal with rather than attempting to replace these teachers by autonomous systems.

Examining the current projects of the lab puts the following point into evidence: a large part of our research work focuses on instrumentalizing human teachers activities and providing them with some support. The apprenticeship situations we create require the teachers to play new roles, to tackle new activities. Expliciting what role should be played by human teachers in order to take the best from the interaction situations we create and specifying what software agents can be built in order to support these teachers are of the core problems we address.

What interested us when putting this point into evidence is how it matches the current debates that the up-coming revolution introduced by Internet causes in traditional educational structures, in our case in the French educational social micro-world. Internet impacts the system in different ways one of which is the potential globalization of the educational offer it introduces. This conducts teachers to reconsider their role, from a positive point of view ("how to use Internet as a powerful vector") or from a less positive and more existentialist point of view ("how to survive Internet impact").

We present here below two research projects of the lab that correspond to very different approaches of constructing learning systems: Croisière, a pre-commercialized Web based distance learning system that teaches French as a foreign language, and RoboTeach, a commercialized environment for micro-robotic activities. We discuss what the teacher role within these types of systems is, how they are viewed by human teachers and what lessons can be learned from these projects that can help us to facilitate the acceptation of new technologies within the social context. Note that our reflection is based on how the LIUM research activities are connected to the French social context. However, we believe that some of the ideas presented here can be useful from a more general point of view.

2 Croisière[1]

Croisière is the result of a collaboration between the LIUM and the CNED (Centre National d' Enseignement à Distance), the French national operator for distance teaching, as one of its very first full-size (2200 multimedia pages, approximately 120 hours of activity) Web-based self-instruction course. The system aims at teaching "French for foreigners", the pedagogical objective being to enable students to develop communicative skills rather than grammatical competence.

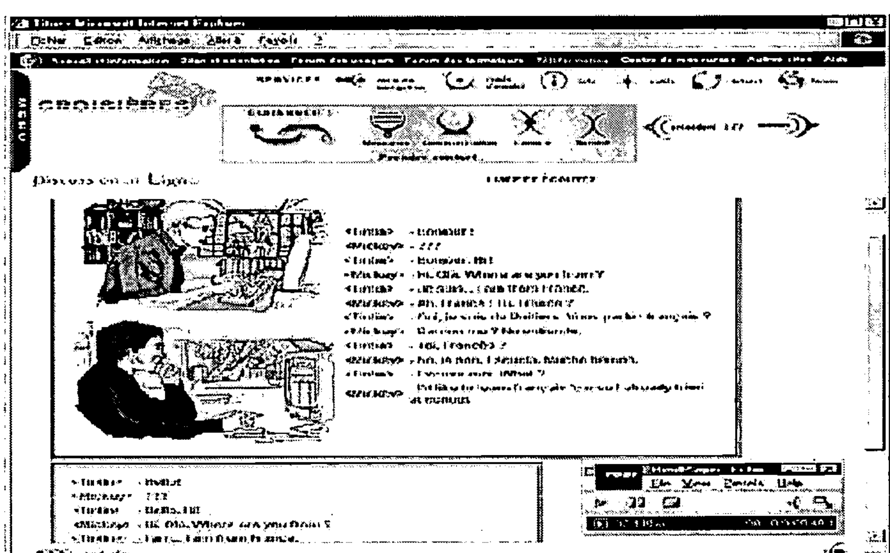

Fig 1. A Croisière module

[1] The Croisière project is managed by Philippe Teutsch (LIUM).

Croisière is specified as a (Web-based) environment that proposes a set of activities and human tutoring. The teaching strategy has been developed by didacticians that have explicited the different types of competencies to be addressed (conversation, listening, exchange, writing and lecture). For every competence a set of activities has been constructed and structured. Fig. 1 presents an example of an exchange module. First, the student is presented with a support-text, its translation and its recording. The second part of the module is a questionnaire that the student must complete according to his understanding of the support-text. Depending on the activities students deliver different productions such as questionnaire answers, text selections or open sentences. Part of these productions (e.g. predefined questionnaires) are managed automatically by the system and part of them (e.g. open sentences) are sent to a human tutor.

Constructing a system such as Croisière is standard state-of-the-art. From a technical point of view, current Web-page generators allow an easy integration of text, image and sound materials. In order to facilitate the construction of new courses the modules are generated using predefined frames and a data-base that contains the different materials. The overall conception of the system is based on a very classical approach of a virtual class: students are provided with educational material and a set of activities to tackle on their own. Every student is (virtually) connected with a tutor he can contact or, from another point of view, a tutor manages a set of individual students. Tutor–student communication is made available through standard E-Mail. Communication between students is not taken into account by the system (we are not in a collaborative paradigm). The most important feature of Croisière environment is in fact its very careful and proven didactic approach.

Within a system such as Croisière, the tutor's role is first of all to correct some of the students' productions. Learning French definitely requires students to produce open sentences, and an understanding (and correction) of such (often erroneous) productions is not in the scope of automatic natural-language understanding current state-of-the-art. The second aspect of the tutor's role is to follow the student progress within the set of activities and provide a first-line support. The tutor-role thus remains indispensable. However, what can be noticed is that such activities are pedagogically poor and do no not valorize the tutor, they correspond to what we can call general guidance and cross-information support.

3 RoboTeach[2]

RoboTeach is an open learning environment developed as the result of several years of research and experimentation within the micro-robotics paradigm, which has proved to be a paradigm that allows creating interesting apprenticeship situations. A micro-robot is typically an articulated arm built from different components (e.g. motors, translation axis or electric contactors) and directed from a computer through a dedicated interface. Students work in groups of two or three. They are asked to perform tasks such as directing pre-assembled micro-robots, assembling a micro-robot from plans or specifying and constructing a new robot from a technical directive book. In fact, the micro-robotic activity is a playground to address different-register competencies: dexterity and precision; problem solving; understanding of technical figures; French expression (explicitation, verbalisation); group work, collaboration and cooperation, social interactions ; space and time organization. In addition to its use for teaching technology, RoboTeach can thus be viewed as a support environment for a teacher who wants to use micro-robots as a paradigm for project pedagogy.

RoboTeach framework proposes a course environment (electronic course books that provide the necessary technical notions), an interface for the students to describe the robot they are working on and a programming environment to define and run the robot control programs. These interfaces have been carefully studied with a multidisciplinary team (pedagogues, teachers) and experimented "in the field" in order to avoid unnecessary difficulties (e.g. syntactical aspects of the robot programming). The environment can be used in different ways by teachers according to their objectives and to their will to invest themselves. When using ready-to-use sequences of activities (e.g. "study these electronic books, construct this robot, define a program that makes the robot put objects from place-1 to place-2"), the teachers' role is to introduce the activity and provide technical assistance.

However, the environment also enables the teachers to create new sequences of activities, modify electronic books or create large-scale projects such as designing new robots.

[2] The RoboTeach project is managed by Pascal Leroux (LIUM).

Analyzing how RoboTeach is used in classrooms allows the identification of how the teacher intervenes and what problems he has to deal with when supporting a set of groups. From a general point of view, teachers are often overloaded by different groups seeking urgent (although often unnecessary) help. From a technical point of view, teachers manipulate the robot, test the programs or analyze students' previous actions in order to identify the problem. From a pedagogic point of view, analyzing the group work is of course a matter for pedagogic interactions (and the difficulty of managing different parallel groups a good argument to ask students to be autonomous).

RoboTeach is currently being re-designed in order to support collaborative work through Internet. From a pedagogic point of view, the idea is to define large scale projects (design of a complete robot and its control programs from a requirement list) tackled by a team composed of different groups distributed over different distant classes. The objective is the classical "learning to cooperate and cooperate to learn". Students get involved in different activities such as general analysis (processed by the team), decomposition of the robot into different modules (processed by the team; each group gets in charge of a module), planning the activity (processed by the team; an agenda is defined in order to synchronize the different groups' activities), robotic activities (processed asynchronously by the groups: use of RoboTeach to perform the group-task, group-documentation and team-documentation). The different activities are instrumentalized by specific tools: agenda editor, shared-document editor, asynchronous communication tools (dedicated E_Mail and Forums), synchronous meeting tool (cf. Fig. 2).

Distance, of course, causes new tutoring problems. As an example we will point out the team-management and the group-management aspects. Group management (i.e., dealing with students located in one class) is an activity that already existed in the standard RoboTeach. From the point of view of managing the process, the tutor's role is slightly different from the "local project" context as the tutor has to deal with the overall team organization. From the point of view of managing technical problems, things are very different according to whether the group is managed by a local human tutor or by a distance tutor via Internet (which is currently a project under work). Team management (i.e., dealing with the different groups) is a new distance activity. The general objective of the team manager is to facilitate the collaboration between the different groups. This can be tackled through both the synchronous and the asynchronous groups and team activities. For instance, Fig2 highlights how the team manager (Sébastien) intervenes in the synchronous meeting in order to approve the proposition of one of the groups.

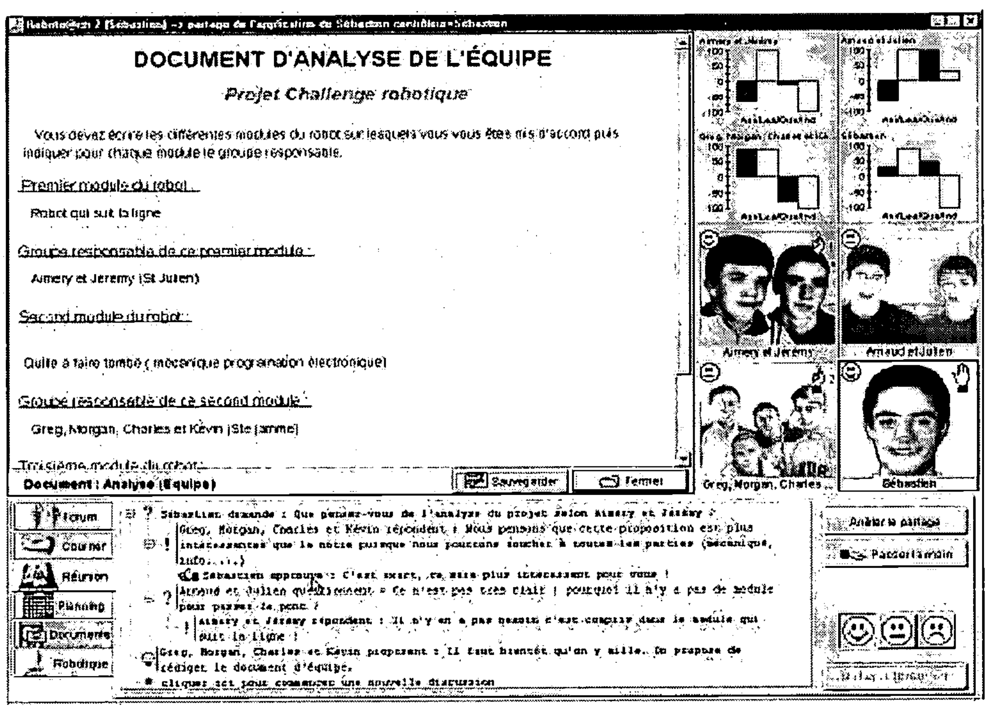

Fig 2. A synchronous meeting with RoboTeach

4 Matching research activities with human teachers' will

While Artificial Intelligence seemed to be a promising technology that will change the face of education, its impact is in fact minimal. Unexpected difficulties (mainly caused by a bad understanding of the problems to be tackled) is part of the reason. Another part is how AI has been viewed by real "in-the-field" human teachers: complicated, useless and psychologically difficult to admit ("you want to replace me by a computer ?"; "thirty years of experience modeled by a simple graph ?"). Internet is seen very differently and, principally, as a positive technology that vehicles notions such as freedom, communication, access to knowledge everywhere by anybody, etc. In any case, teachers are convinced that, positive or not, they will have to deal with Internet.

However, when it is the time for a large-scale introduction of Internet-based systems, more negative points of view reappear. As an example, what is discussed and how it is discussed in the context of the introduction of new technologies for open and distance learning within the French University system reveals how Internet impacts the system. Specialists involved in the domain explain what can be done, how Internet permits distance learning, new pedagogic situations (..) and being competitive on the educational market. If many teachers adhere with enthusiasm to such an evolution, many others focus exclusively on the last argument ("being competitive on the educational market ") and what it implies: the good old world (students need competencies to have some work, University provides competencies, therefore, students come to University) is a lost world. This "ideal" vision resisted the fact that other (for instance private) institutions provided some competence as long as this alternative offer remained limited. But Internet gives some consistency to the *cliché* of the very rich very competent international University based anywhere in the world that provides worldwide students with an excellent teaching system and renders all the other Universities obsolete. Moreover, diplomas are no longer the national Universities' prerogatives as (for instance) the European construction already permits diploma cross-reconnaissance (as an example, the UK Open University currently award diplomas to students residing in France). In other words, education is an industry and many teachers suddenly realize that they are in a competitive world, that it is here and now, that it concerns their competence and their job.

5 Socially viable systems

As what we are discussing here can be considered as far away from pedagogic problems, we will recall our credo: computer scientists involved in the field must study the implications within individual and social behaviors of theoretical and technical advances. As said before, AI was supposed to render human teachers obsolete and useless, but nothing happened. From this point of view, Internet appears as socially much more dangerous.

The impact of Internet on educational societies is of course very contextual. In the French and European context, how Internet is seen as a potential danger cannot be disconnected from the current movement against the generic notion of "globalization" as it appeared for instance in Seattle when all sorts of organizations protested against the World Trade Organization's trade policies. Many people worldwide and especially in Europe and France promote alternative models of society. Within this general context, a parallel is made between farmers fighting against genetically modified products or use of hormones and teachers fighting against an international Internet-based educational offer, i.e. education viewed and promoted as a product independent from the cultural specificities, human-human relations, etc. Note that such points of view also find some echo within the educational-systems users.

In such a context, it is not surprising that many teachers (and students) do not feel very comfortable with approaches such as Croisière. The explicit argumentation is concerned with the intrinsic educational value of such systems. The implicit idea is bound to the fact that a very little set of tutors can manage a very large number of students. On the contrary, a system such as RoboTeach is seen very differently as it makes the most of the intrinsic and un-automatizable capacities of human tutors. In other words: some systems appear as more "socially viable" than others. Note that not only the intrinsic nature of the system (standalone teaching system vs learning environment) participates in the way the system is socially viewed, the considered domain also has some influence: people are more prone to accept automated systems dedicated to robotics than to a culturally connoted domain as a foreign language.

We will not discuss the effectiveness of such points of view (although it would be an interesting discussion), what is important is that we have to deal with such a context.

6 Supporting teachers: an educational and social requirement

Introducing new technologies in classrooms requires making computers accessible and enabling the teachers to take the best of them. Forgetting this latter aspect conducted to the failure of many programs. Therefore, institutions attempt to make teachers aware of what can be done with computers. Such an objective is addressed for instance by national programs such as the US Department of Education International Society for Technology in Education "NETS for Teachers" project, that is devoted to "preparing tomorrow's teachers to use technology" on the basis of a national consensus on what teachers should know about and be able to do with technology[3].

On the other hand, we must of course attempt to build systems on the basis of socially situated analyzes of how teachers really use computers. For instance in France a recent study pointed out that "education is less concerned by ready-to-use software than by software that can be customized by their users according to their own conception of what they must teach and how they must teach it"[4]. From this point of view, a system such as RoboTeach appears as perfectly adapted.

However, we have to deal with the fact that RoboTeach-like systems are time-consuming, money-consuming and, teacher-consuming projects and that less adapted systems and systems that allow very little latitude to the tutors (e.g. Croisière) already exist and will proliferate. We must thus consider all the different types of systems and not only the ones that correspond to our will.

As we do not work on Intelligent Tutoring Systems but on learning environments that teachers/tutors can deal with, what we point out is the difference between stock and service. Stock, i.e. providing high quality educational material, is no more the prerogative of human teachers. Internet allows anybody (if economically solvent) to be presented with high-quality materials produced by national or private business institutions. Service, i.e. providing a positive context, interacting with students, exploiting situations to provide a constructivist education (etc.) remains human teachers' prerogatives and they are issue of teachers' creativity.

Systems such as RoboTeach expect tutors to play a pedagogically rich role. They are viewed positively because they are based on the intrinsic and un-automatizable capacities of human tutors. However, this can become a weakness if using such systems requires "specialized" tutors. We believe that we have to work to make these systems economically viable. For this purpose, we have to design and construct support systems that will help "basic" teachers to make the best of such systems.

Systems such as Croisière theoretically only require a very simple tutoring, The quality of the educational material and the didactic structure they are provided with are supposed to be sufficient to enable the students to manage by themselves. However, we believe that we must study how we can build systems dedicated to the tutor that present him with a synthetic view of the students' actions and behavior. First, because this will valorize the tutor role and facilitate the social acceptation of such systems. Second, because it will help tutors to manage their basic tutoring tasks. Third, because we believe that human tutors' natural inclination is to invest themselves, to invent new unexpected ideas, new educational services or new roles as soon as they are put in a valorized situation. Tutors provided with synthetic information will go further than a simple "cross-information" tutoring. This is particularly important for domains such as learning French as the tutoring activity has to take into account the social and cultural specificities of the students.

In other words, we believe that integrating in educational systems functionalities that are explicitly dedicated to supporting the human teachers who have to deal with them participates both to the "social" acceptation of the technology and to its best use (the "social" aspect being a prerequisite to its best use). This must be achieved both for "well-fitted" systems and with others, with the objective to make teachers aware of the difference between stock and service.

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[3] http://cnets.iste.org/index3.html

[4] http://www.industrie.gouv.fr/observat/innov/rntl/groupeb2.htm

7 Problems to be addressed

In a system such as RoboTeach, the fact that the tutor role is pedagogically rich renders the support functionalities a sine-qua-non condition. The general problem is that of the tutor's overload, that requires automatizing part of the support currently provided by human tutors in order to allow them to focus on their core role. For instance in the distance learning RoboTeach version we have two types of tutors, the group tutor (in the distance group tutor configuration) and the team tutor. Of course, what comes first in mind is the technical point of view, i.e., how to manage distance group tutoring. A distance group tutor cannot manipulate the robot and the environment must thus provide the information he needs (in our current work we address the problem with a multi-agent spying architecture). However, the technical aspect is only part of the problem. For instance, within RoboTeach a teacher is no longer a "stock" of technical micro-robot technology but a team or a group manager. This is not what he has been trained for and he must be helped while achieving this task. Moreover, using RoboTeach in a distance context requires the teacher to manage new inputs (what the spying agents can grasp) and to interact through new media. For instance, one of the roles of the team manager (Sébastien in Fig. 2) is to help the different groups to take the best of their synchronous discussion. For this purpose, the tutor has to highlight his position towards the different groups' discussion (approval of an idea, etc.). This is instrumentalized within the environment by the fact that the forum is structured according to a typology of language acts that are supposed to facilitate the students' collaboration. Human tutors should be supported to achieve such a complex activity. For instance, the tutor should be presented with a pedagogically dedicated view of the group actions, robot state and first line software agents actions. If we cannot neglect the technical problems, what is crucial is in fact the identification of what the information that is needed by the teacher is, how it should be synthesized and presented to the teachers and how these teachers can intervene.

In a system such as Croisière students are supposed to manage on their own. They learn by doing individual actions (in this case, reading texts, listening to audio, looking at videos, etc.) and being aware of their activity (in this case, evaluating themselves by answering questions and producing texts). As real students do not necessarily deal with sufficient auto-organization abilities, the tutor's role is mainly to provide them with some organizational and cross-information support. Automatizing such a support (e.g. building a software companion that explains how to use the system, orientates towards additional educational material, presents other students' answers or provides some guidance through the different activities) appears as technically tractable. The core difficulty is to identify what data is meaningful for the human tutor in order to facilitate additional pertinent interventions, i.e. provide a synthetic view of the student course and actions.

In both cases the problem is to dissociate what can/must be taken in charge by first line automated agents and what can/must be delegated to the tutor, i.e. to construct models that mix automated and human tutoring. While constructing these models we have to take into account both "social aspects" and "technical aspects" (what can be grasped from student-action spying, how the tutor's actions can be mediatized). Of course, things are easier to take into account when inventing systems proposing pedagogically rich roles than when attempting to permit humans to add additional services to systems designed without this objective. This is why we have to accentuate our work towards designing support systems for such contexts.

References

[1] Leroux P., Vivet M. (2000). Micro-robots Based Learning Environments for Continued Education in SMEs. The Journal of Interactive Learning Research, Special Issue on Media Technology for the further Evolution of Learning Paradigms (under press).

[2] Vivet M., Beacco J.-C., Teutsch Ph., Gueye O., Di Giura M., Tauzer-Sabatelli F. (1999). Croisières: Le Français pour débutant sur Internet. Deuxièmes Entretiens Internationaux du CNED, Poitiers Futuroscope (under press).

The role of emotional agents in Intelligent Tutoring Systems

Claude Frasson

Many attempts have been made in Artificial Intelligence for reproducing human behavior or reasoning, adding believability and humanism. Recent works have shown the importance of emotions for including a human-like perception. Emotions are particularly important in Intelligent Tutoring Systems that try to reproduce the behavior of good teachers. They also can be integrated into social learning systems to reproduce reactions between learners or between learners and teachers. Emotions play an important role in the learning process and new strategies have to take into account this human factor for improving knowledge acquisition. Intelligent agents can help in this process, adding emotional behavior to believability of their actions. This talk discuss some main orientations and results in emotional agents that can strengthen the social interaction in a learning environment. We show in particular how to represent and quantify an emotional status, as well as a means to guess the learner's emotional state.

Web Portfolios: Tools for Monitoring and Assessing Learning Process

Gwo-Dong Chen

Portfolio is a purposeful collection of student work that exhibits the student's effort, progress, and achievement. By adopting portfolio assessment in a web learning system, web portfolio not only contains learning activity log recorded by web server in web log but also portfolio submitted by students that represent their learning process, learning result, and learning evidence. Thus, web portfolios provide enough information for teachers to (1) make decision for applying learning strategies, (2) be aware of student performance, and (3) model student learning performance by analyzing student portfolios. However, the web portfolio is too big and unorganized for a teacher to handle in achieving the above-mentioned tasks. Thus, tools are built for providing information to assist teachers in performing the tasks.

Keywords: portfolio, assessment, student model

Can And Should Teaching Systems Mimic Human Teachers?

Benedict du Boulay

In the 1980s Ohlsson offered a critique of ITSs and ILEs in terms of the limited range and adaptability of their teaching actions as compared to the wealth of tactics and strategies employed by human expert teachers. The purpose of this paper is to examine how far that critique still holds true. One of the promises of ITSs and ILEs is that they will teach and assist the learning process in an intelligent manner. Historically this has tended to mean concentrating on the interface, on the representation of the domain and on the representation of the student's knowledge. Systems have attempted to provide students with reifications of the domain and of the learning process as well as optimally sequencing and adjusting activities, problems and feedback to best help them learn that domain. Of course, we now have embodied (and disembodied) teaching agents, computer-based peers, and a much greater interest in collaborative activities and tools to support that collaboration. Nevertheless the issue of the teaching competence of ITSs and ILEs is still important, as well as the more specific question as to whether systems can and should mimic human teachers. Are we in any better position in modelling teaching than we were in the 80s? Are Ohlsson's criticisms still as valid today as they were then? This talk will review progress on understanding human expert teaching and in developing systems that embody those human teaching tactics, referring in passing to work carried out at Sussex: for example, on responding effectively to the student's motivational state, on contingent and Vygotskian inspired teaching strategies and on the plausibility problem. This latter is concerned with whether tactics that are effectively applied by human teachers can be as effective when embodied in computer tutors.

Human activity in learning societies

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This paper suggests a framework for thinking about the themes of the Conference — learning societies, creativity, caring and commitments. The focus is on human activity but this has to be placed in the context of what is meant by a learning society and what might be the motivations and intentions for change in such societies. An interpretation of Activity Theory is used to identify insightful foci for the complexity of issues — *pedagogical, social, technological* — that influence human activity. An analysis of the context of working together, either collaboratively or cooperatively, makes a clear and important distinction between the two. This becomes important as human activity in undertaking tasks passes through various stages over time, and the focus of the immediate task changes. Information and communication technology may promote and support change but how can these tools be managed and their value exploited for the benefit of all members of society?

Keywords: **Activity theory; Collaboration; Cooperation; Human activity; Learning communities**

1 Introduction

It is first necessary to establish what we mean by the term 'learning societies' and for this it is helpful to draw on the notions of *learning organisations* developed in the management literature and extensively reviewed by Easterby-Smith and colleagues (1999).

However, caution is required as learning organisations may be *intentionally* created in order to capitalise on knowledge within an organisation and hence to improve its competitivity. For this reason, there is an explicit intention, an explicit goal, and, whilst this has social implications, it is the latter that may be predominant, yet implicit, in a learning society.

Quite often organisations are propelled into action by a failure or a threat that has arisen. Is this the case in society at large? Why are we concerned at this moment? Perhaps one clue arises from the foci of creativity, caring and commitment that suggest that there is a lack of these features in the way that society is developing. To many in society, child labour, the excessive emission of greenhouse gases, oil pollution of the seas and international trading in weapons are a few of the many ills of present society.

As mentioned earlier, learning organisations are being created in companies, often from the top, but with the explicit *intention* of bringing about change. Learning societies will be created only when social *intentions* are made explicit and are accepted. As educationalists, it appears to us that to enhance learning might change social attitudes and bring such regrettable actions to an end. Perhaps information technologies have a role to play but this can be the case only when explicit intentions are established.

In order to help us think about the complex dimensions that make up society, we need a framework that temporarily isolates the various parameters of human activity and this will now be explored.

2 Human activity

Activity is rarely carried out individually. Groups or teams work together to achieve a goal and the skills of individual members are brought together for this purpose. In the area of cognitive development, the classical notions of Vygotsky are helpful.

One may consider that the knowledge of an individual has a central core which is 'owned' by the individual, who is able to use that knowledge in the autonomous performance of tasks. Surrounding that core is a region (the zone of proximal development — zoped) in which the individual has some knowledge, but needs help in performing tasks which depend upon that knowledge. It is important to stress that Fig. 1, which is an attempt to represent this perspective, should not be viewed as a physical model. Core knowledge is not just that which is internalised but represents the 'system' (other people and artefacts) in which people function as asserted by the distributed cognition approach.

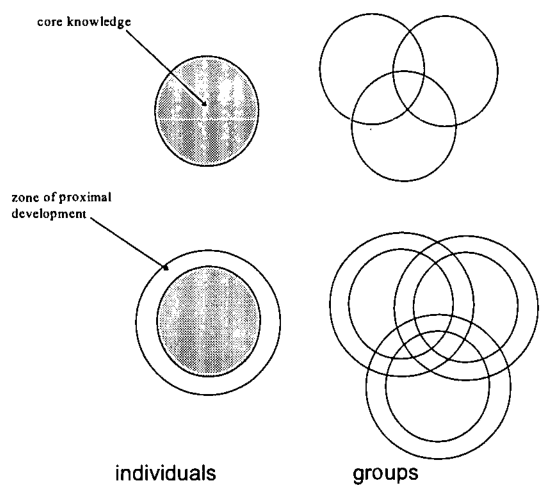


Fig. 1. Core knowledge and zones of proximal development (from Lewis, 1995)

As suggested by Fig. 1, when a community of humans is considered, some parts of each person's core knowledge overlap those of others and, most importantly, one person's 'zoped' overlaps with the core knowledge of others. From this model one might conclude that the collective core knowledge is, not surprisingly, greater than that of an individual but also that each person can support cognitive development in the group by providing 'scaffolding' for others in domains where their knowledge is not yet available for autonomous use. Recent research (reported by Schwartz, 1995) supports this view through the analysis of the performance of pairs of learners. It is suggested that (in certain circumstances) the performance of dyads is much better than would be expected from the simple addition of each individual's performance.

This collective potential can be realised only if each member of the community is aware of the knowledge of others and can capitalise on that by offering and receiving help from the others. To be effective, the group working together must appreciate that the knowledge of the group does not reside in individuals but is distributed amongst them — the term 'distributed cognition' is sometimes applied to this situation though the term is broader and includes artefacts. Schwartz (*op cit*) suggests that the creation of abstract representations (rules or visualisations) is a key to collective problem solving; for example, students who drew sketches to represent the problem they were attempting to solve together were more successful than those who did not do so. The act of drawing the rough sketches formed a common representation of the problem, which is how they created a mechanism for the 'construction of shared representation'.

This viewpoint argues strongly for the design of learning environments in which learners, by making their knowledge explicit and visible to others, can become engaged in undertaking a common task and solving a common problem.

However, there is more than one way of 'working/learning' together and the distinctions are very important. Two terms often used are *collaboration* and *cooperation* and there is a significant difference between the two. There are many definitions of these terms, for example:

> "Collaboration is the process of shared creation: two or more individuals with complementary skills interacting to create a shared understanding that none had previously possessed or could have come to on their own." (Schrage, 1991)

The nature of cooperation has also been expressed in the following way:

> ". . . the term 'cooperative' is the general and neutral designation of multiple persons working together to produce a product or service. It does not imply specific forms of interaction or organisation such as

comradely feelings, equality of status, formation of a distinct group identity, etc." (Bannon & Schmidt, 1991)

Some clarity emerges if the notions of Activity Theory are invoked. A key dimension in this theory is the concept of 'intention of action'.

Cooperation depends upon a supportive community of actors who agree to help one another in activities aimed at attaining the *goals of each person* involved. *Collaboration*, on the other hand, depends upon the establishment of a common meaning and language in the task which leads to the community setting *a common goal.*

This last point is emphasised by Littlejohn and Häkkinen (1999) who acknowledge various definitions in the research literature but note that: "*. . . there is a consensus amongst researchers that collaboration involves the joint construction of meaning through interaction with others and can be characterised by a joint commitment to a shared goal.*"

One way to illustrate the distinction is to take the example of a team of people wishing to write a book (Fig. 2). They may decide, having established the scope of the chapters, to allocate the responsibility for each chapter to one member of the team. In the way the term is used here, that means they will *cooperate* in the production. On the other hand, they may decide that everyone will contribute to all the chapters — that is, they will *collaborate* in the production.

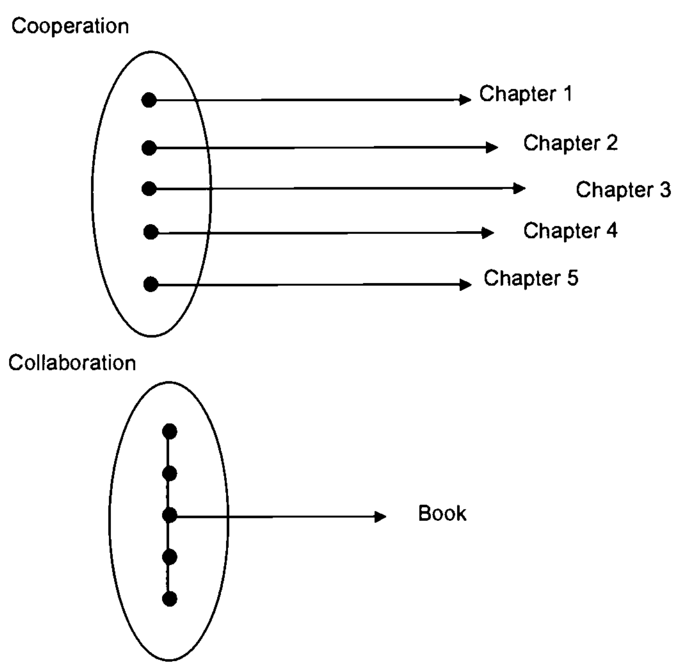


Fig. 2. Cooperation or collaboration in writing a book.

To what extent might learners establish common intentions with others (so that they might collaborate) and to what extent might learners accept that their peers have different intentions (and yet still see benefits in cooperating)?

Before beginning to answer that question, it must be stressed that the case for 'learning together' may be more an 'act-of-faith' than a well-proven and tested mechanism. The situation is well summarised in the following conclusions to a paper which reported on problem solving and peer interaction:

"Nobody should suppose on the basis of (existing) studies that truly collaborative work is going to provide a panacea for education. Indeed, rather exacting conditions may need to be met before it proves possible at all. However, it seems likely that a better understanding of the mechanisms at work in such interactions may make it possible to improve significantly upon this aspect of educational practice and the potential benefits are considerable." (Light & Glachen, 1985)

3 Stages of activity

Linard (1995) described Leontiev's (1978) and Von Cranach's (1982) three hierarchical levels of human processes, each of which are related to a type of object. These levels may be interpreted as follows.

- The *intentional level* is oriented toward motives: needs, desires, or values. It is the level of global orientation that gives meaning to human processes.
- The *functional level* is oriented to specific, conscious goals in the context of motives. It is the level of focused organisational, planning and problem-solving processes in order to achieve a final goal or intermediate goals.
- The *operational level* is oriented to the practical conditions of actions which are a prerequisite to the conscious, purposeful actions at the functional level.

The intentional level provides context for the functional level, which in turn serves as a focus for the operational level. The framework is flexible, however, in that the level of a particular activity depends on the task; for example, developing an internal communication and management structure may be quite routine for one research group, but a challenging activity for another.

An important characteristic of the framework is its dynamic nature, in that human processes may move from one level to another as a result of 'frustrations' relative to their objects. 'Frustrations' or contradictions may be the result of external factors changing. For example — continuing the illustration above — if a problem is met in the practical routine of organising the community's communication (operational level), strategies for adapting the communication structure may be needed. Therefore a new goal is formulated, and the focus of human action moves up the hierarchy to the functional level. Once the new routine is agreed on, the action may take on an operational character again.

Contradictions may also result from the interconnectedness of webs of activities in real-life situations (Kuutti, 1991): each community member participates in multiple activity frameworks, including multiple communities, and developments in one activity framework may influence and lead to contradictions in others. The shifts in the focus level of human activity could, for example, follow the changes indicated in Fig. 3.

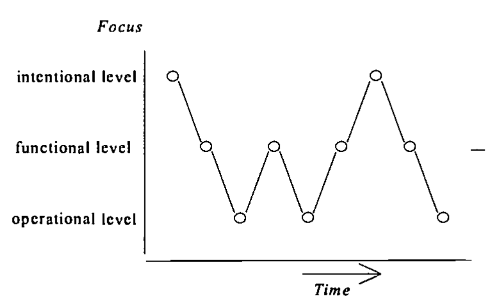


Fig. 3. Over time, the focus of human activity is at different levels.

Contradictions or 'frustrations' are thus a source for development on all three levels (Kuutti, 1991). In addition, this development provides human activity with *intentionality and history* which serve as a context for understanding human processes (Kaptelinin, 1996). Hence, Activity Theory provides a rich and dynamic perspective on human activity including team work in distributed working and learning communities.

4 Activity theory

Activity Theory (AT) has its origins in the Russian tradition of socio-historical approaches some 70 years ago and can be characterised by a combination of (a) objective, (b) ecological, and (c) socio-cultural perspectives on human activity (Kaptelinin, *op cit*, p. 107). The basics and the applications of AT are very well described in a recent book (Nardi, 1996) and only certain elements will be outlined here. Kuutti (1996, p. 28), inspired by Engeström (1987), represents the structure of an activity in the diagrams below. Figure 4 includes an individual's actions to achieve an object where the action is *mediated* by artefacts (tools) and Fig. 5 extends that to a community context with the addition of rules and divisions of labour.

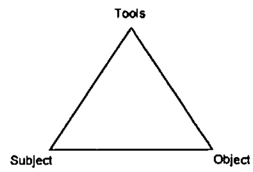


Fig. 4. Mediated relationship at the individual level (after Kuutti, 1996)

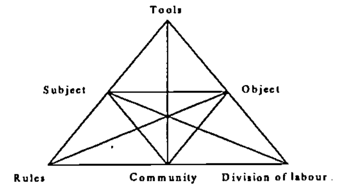


Fig. 5 Basic structure of an activity (after Kuutti, 1996)

A narrative for Fig. 5 could be: an individual (subject) is helped by tools to achieve an objective (object) and may accept rules to work in a community which contributes to the object through a division of labour. From such an activity there is an outcome.

Another notion contained in AT is that of hierarchical levels:
activity — action — operation

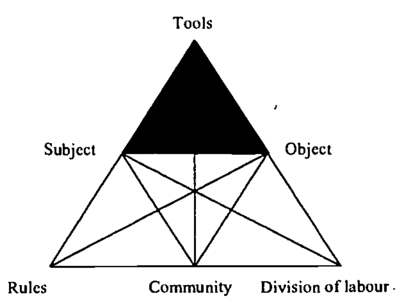
An activity (global) may be achieved through a variety of actions, and the same action may be used as a contribution to different activities. Similarly, operations may contribute to a variety of actions. Kuutti (1996, p. 33) uses a simple example of these levels when the activity (motive) may be 'building a house' in which 'fixing the roofing' and 'transporting bricks by truck' are at the action level; and 'hammering' and 'changing gears when driving' are at the operation level.

5 The framework in action

Activity Theory points to critical features of effective working communities and it is constructive to consider ways in which they can be applied to create frameworks for distributed communities. The nodes of Fig. 5 form a possible structure for analysis (see also Lewis, 1997 and 1998).

Attempts to consider all the relationships influencing human learning activities are likely to fail due to the multitude of interdependent parameters but it may be that the complexity can be constrained if various triads of nodes taken from Fig. 5 are examined one at a time. Some of the triads include 'community' and these may help to focus on creativity, caring and commitments. Papers from the ICCE99 proceedings will be used to illustrate how the triads may help such focusing.

5.1 Subject-tools-object



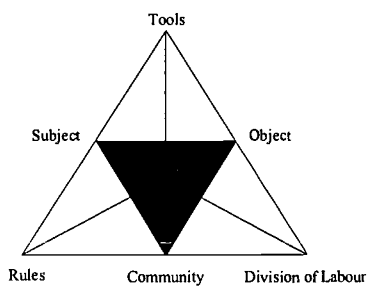
When analysing the papers in ICCE99, it is clear that most of the reported research is concerned with developing tools which allow a 'subject' to achieve a learning 'object'. The panel at that conference discussed verbal and visual tools (Okamoto, 1999).

> "The goal of this panel is to debate on human activity, communication skills, methods of (self-) expression and logical thinking ability, in the context of the new growing Internet society." (p. 80)

Major sections of the conference were devoted to topics such as agents, intelligent support, web resources and interactive learning environments all of which are in effect simply tools to support a subject to attain a (learning) object. The creation of such tools may also require tools such as authoring systems for the creation of materials for learning and it can be argued that the training of teachers can also be viewed as the development of (human) tools which are used by students in the process of their learning.

However, the main theme of this paper is on society which comprises a variety of communities and it is the triads that include 'community' which will be explored. It is worth remembering though that the 'subject' may be an individual or a group (a community) and that communities are often members of other larger communities; also, that an individual will surely be a member of different communities. When considering both these structures, it is necessary to rethink the nature of the most appropriate tools to be used.

5.2 Community-subject-object



This triad focuses on how 'subjects' reconcile personal goals so that these lead to actions to support a community. Can a common goal become established? An activity emerges or is set up with a number of intentions. In a community this requires the establishment of a 'common language' amongst all members who come to be *committed* to a shared, explicit motive (object). In other words, the actions cannot be set along predetermined lines; there must be space for interpretation, negotiation and the establishment of both individual and group ownership of the motive. Watabe and Yuze (1999) draw certain conclusions relating to *creativity* from their experiment with students working on projects as individuals or in small groups.

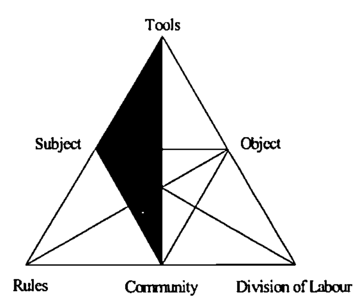
"a) In collaborative learning, the subjects could hit upon such new ideas as they would never reach if they thought by themselves. This enabled them to see a problem from another point of view. On the other hand, in individual learning, a subject tended to stick to his/her idea, which made it difficult to change his/her standpoint.

b) In collaborative learning, the idea was deepened as they discussed it. For example, when a subject was reading an article about a case and was wondering why that had happened, the others thought from various angles and tried to find out answers. The subject accepted the explanation they offered and then a new problem was proposed. Through these successive events, the discussion was deepened and spread. On the other hand, in individual learning, subjects did not hear others' opinions and therefore they seem to reach their conclusion before thinking deeply." (p. 176)

Ang and colleagues have identified the establishment and maintenance of common goals as a critical feature of collaboration:

> "In order to collaborate with other members of the learning community, members must be able to agree on some shared goals for the community. The goals will help the members to stay focused and also assess whether they are achieving what they set out to do. Members must be able to negotiate meanings and not just accept what was said. Otherwise it becomes an information exchange without construction. (Ang, *et al.*, 1999, p. 604)

5.3 Community-subject-tools



This triad is concerned with how tools are selected in order that they support, equally, all members of a community. It draws attention to the personal skills of members, some of which are social as they relate to capitalising upon available help from peers and tutors (seen in this context as 'tools'), and to skills in the use of the technological tools available. If community activity is to have full participation, communication tools should be selected which are accessible to and easily usable by all members.

Returning to intentional learning communities: it is clear that tutors play a key role, not only in being instrumental in making appropriate channels freely available but in monitoring how they are being used and in taking corrective action to sustain fragile learning communities. Ogata and colleagues (Ogata *et al.*, 1999, p. 277) experimented with an agent which made links between groups of students working on collective tasks. They reported that "*a matchmaker agent took the burden of the work instead of the teacher.*" Nakamuru and colleagues (Nakamuru *et al.*, 1999, p. 685) also experimented with individual and group agents; they included a difference model to assess the variations of opinion between members of a group.

This triad of nodes also extends to include the design of groupware — software designed for group communication, shared workspaces, the collective editing of documents, etc. The focus in this triad is on the *subject(s)* rather than on the object. The constraint of ubiquity referred to above is critical.

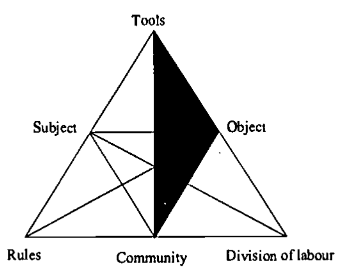
Watabe and Yuze (*op cit*) also comment about the limitations of the synchronous communication system used in their experiment:

> "In collaborative learning, even when a subject finished reading part of the screen, he/she had to wait until the others would finish with it because they shared the lesson material window. It was also necessary for a subject to get the assent by partners to go to the following subject (topic) during discussion." (p. 175)

Svensson and Östlund (1999) report on the value of the bulletin board system that they made available in a department:

> "The communication that took place on the SQ-board bare the mark of a novel cybergenre. The content of the e-Quality genre has two different strands. On the one hand it is focused on a rich discussion about intended quality issues, (i.e. services and education) and on the other hand there are clear traces of the community building process." (p. 696)

5.4 Community-object-tools



This triad draws attention to how tools (for example, hypermedia materials) may be designed and used so that they support the achievement of the *object* of the community. How well do they support the achievement of the community goals? The interpretation of tools in Activity Theory needs to be made explicit.

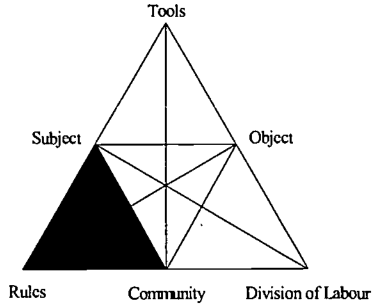
"An activity contains various artefacts (e.g. instruments, signs, procedures, machines, methods, laws, forms of work, organisation). An essential feature of these artefacts is that they have a mediating role." (Kuutti, 1996, p. 26)

Buiu and Aguirre (1999) are concerned with this triad as they consider the requirements for an intelligent user-interface (IUI):

> "The purpose of the research reported in this paper is to study advanced issues in this area of IUIs with learning capabilities. The main problem concerned is that of designing and technically realizing interfaces that make human-computer interaction easier and more effective and make complex co-operational relationships easier to grasp. The application domain we have chosen is collaborative problem solving." (p. 301)

This triad also draws attention to the fact that the definition of the object by a community will be influenced by the availability of specific tools. AT is concerned with the whole environment and so this formulation should include human artefacts: those people who are not a part of the community of learners (for example, tutors, gurus) but who may provide considerable 'mediation' in the tasks being performed.

5.5 Community-subject-rules



This triad centres on the protocols of interaction. How do 'subjects' establish rules for their interaction? The simplest example of this in the context of groups using communication technology is the meaning of 'no reaction' when a proposal is made (by email or in a conference) to take a certain decision. At a face-to-face meeting, the interpretation is usually accepted as agreement; in an electronic interaction, some ambiguity remains unless the reaction is explicitly defined in the interaction protocol. How the protocols are established relates to the role of individuals in the community and their expectations of others and of themselves.

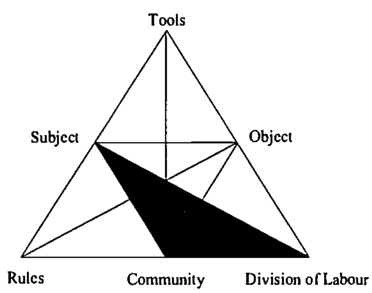
Svensson and Ostlund (*op cit*) clearly have this issue at the heart of the experimentation that they report. Despite the valued overall outcome of community building, it is not clear how well the protocols of interaction were established or shared in any explicit way.

> "The Community-aspect that is represented in all thread categories points to a set of tacit and shared norms, stating what can and cannot be done on the board. These norms surface when being tested, challenged or violated, often resulting in corrective remarks." (p. 695)

Nowhere in a learning context is the agreement about rules as critical as in the assessment of learners' knowledge. Bhattacharya and colleagues (Bhattacharya, *et al.*, 1999) have experimented with a system for collaborative evaluation during problem-solving activities. It is clear that the 'rules' for assessment must be negotiated with the learners as there is self and peer rating as well as teacher rating.

> "These three ways of rating have been adopted to assess a board range of skills, including effort, self-directed learning, group cooperation and communication skills. Use of ratings from peers and teachers is based upon the belief that co-workers are in a good position to evaluate each other. Use of self rating is congruent with problem-based learning's emphasis on judging the state of one's own knowledge as an essential element of the learning process." (p. 181)

5.6 Community-subject-division of labour



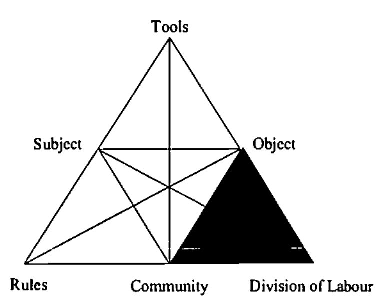
This triad focuses on how a division of labour is established and maintained in order to be effective. It is when thinking about this issue that the question of intentions arises and highlights the question of whether the group is to work through cooperation or collaboration. During cooperation, the object of each member of the community might be different but achievement of the common goal is attained through a certain division of labour with other members of the community. During collaboration, a different division of labour is necessary to ensure that the capitalisation of individual skills reinforces the clear ownership of the global, shared task.

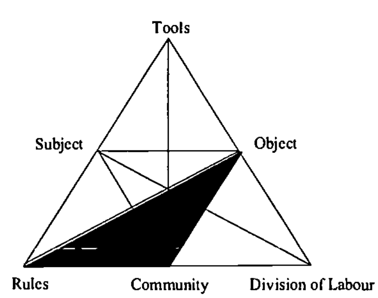
Ang and colleagues (*op cit*) consider this area in their conceptual framework:

> "Cooperative work is accomplished by the division of labour among participants. Members have different talents and skills. For example, some members may be better at web page design, while others may be better in content knowledge. The tasks can be divided such that there are multiple ways for members with different skills to participate." (p. 604)

It is important to be aware that the nature of the activity will change over time (Fig. 3) and so both the rules/protocols and division of labour will need to alter. This dynamic nature of activity is a topic that Engeström (*op cit*) has examined in very interesting ways.

5.7 Community-object-division of labour/rules





The left-hand triad focuses on the object of the community, making the members of the community secondary to the achievement of the common object. It is in strong contrast to the previous triad in which members' wishes and satisfaction were paramount. However, only in an authoritarian regime could (in theory) an individual's motivation be ignored. Again, the distinction between working and learning on shared tasks may be important.

The concern of the right-hand triad is how rules (protocols) support the community to meet their common goal. Again, the 'subjects' take a secondary role; it is rules which allow the attainment of the object which are paramount. However, rules can be established which are seen by the members of a community to be supportive in the achievement of common goals and individuals may accept certain rules unwillingly but for the common good.

These last three triads demand a full consideration of the organisation of the group. Both the rules and the division of labour form the management structure of the community and, again, this will need to change as the nature of the task varies. For example, in setting up a community to undertake an activity, it will be necessary to begin with a very democratic structure so that each person 'owns' the task in hand. At a later stage, it will probably be most efficient to allocate specific responsibilities to one of the group, maybe establishing a protocol in which each member takes it in turn to lead the group for a period of time. Two possible structures may be illustrated by the communication pathways shown in Fig. 6.

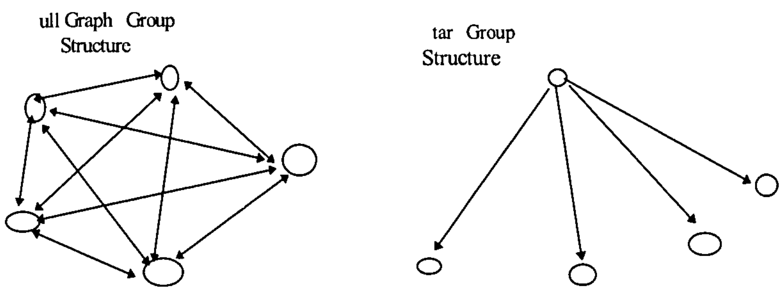


Fig. 6. Communication in two possible group structures

This theme emphasises a major distinction between working and learning communities. In the former, a member may take on a minor role which matches his/her competence or availability to devote time to the activity. In a learning community the task must be capable of subdivision such that every member can contribute (in time and impact) equally. This is very difficult to achieve especially when some members may have greater commitment to the task and be able to offer more than others and yet all are to be assessed on the same basis. This also raises the issue of how the assessment is to be undertaken when it may not be transparent who contributed what to the common task.

6 Conclusions

No single theory or framework can be expected to cover the highly complex domain of human activity in complex, changing societies. However, the examples given in this brief paper do illustrate that some of the complexity can be unravelled by the use of this interpretation of Activity Theory.

Of the set of concerns which this Conference is exploring, I'm afraid it is that of *caring* that I have failed to weave into this 'story'. There were just a few papers at ICCE99 that touched upon disadvantaged learners, learner satisfaction and environmental issues, but perhaps during ICCE2000 this situation will be remedied. The theme clearly falls within the 'community-subject-object' triad which also includes creativity and commitment. Perhaps caring as such cannot be isolated from creativity and commitment to other members of society. I look forward to hearing more on this topic during ICCE2000.

References

[1] Ang, D.B.S., Chan, H.C. & Lim, J.L.H. (1999) Learning Communities in Cyberspace: A Porposed Concentual Framework. In *Advanced Research in Computers and Communications in Education Vol. 1* (eds. G. Cumming, T. Okamoto & L. Gomez) pp. 600-607. IOS Press, Amsterdam.

[2] Bannon, L.J. & Schmidt, K. (1991) CSCW: Four characters in search of a context. In *Studies in Computer Supported Cooperative Work* (eds. J.M. Bowers & S.D. Benford) pp. 3-16. North Holland, Amsterdam.
[3] Bhattacharya, M., Tanagisawa, M. & Akahori, K. (1999) Internet Based Collaborative Evaluation of Learning in a PBL Environment. In *Advanced Research in Computers and Communications in Education Vol. 2* (eds. G. Cumming, T. Okamoto & L. Gomez) pp. 181-184. IOS Press, Amsterdam.
[4] Buiu, C. & Aguirre, G. (1999) Learning Interface for Collaborative Problem Solving. In *Advanced Research in Computers and Communications in Education Vol. 1* (eds. G. Cumming, T. Okamoto & L. Gomez) pp. 301-303. IOS Press, Amsterdam.
[5] Easterby-Smith, M., Burgoyne, J. & Araujo, L. (eds.) (1999) *Organizational Learning and the Learning Organization*. Sage Publications, London.
[6] Engeström, Y. (1987) Learning by expanding. Orieta-konsultit, Helsinki.
[7] Kaptelinin, V. (1996) Activity theory: Implications for human computer interaction. In Context and consciousness: Activity theory and human computer interaction (ed. B.A. Nardi) pp. 103-112. MIT Press, Cambridge, MA.
[8] Kuutti, K. (1991) Activity theory and its applications to information systems research and development. In *Information systems research: Contemporary approaches and emergent traditions* (eds. H.-E. Nissen, H.K. Klein & R. Hirschheim) pp. 529-549. North-Holland, Amsterdam.
[9] Kuutti, K. (1996) Activity Theory as a Potential Framework for Human-Computer Interaction Research. In Context and consciousness: Activity theory and human computer interaction (ed. B.A. Nardi) pp. 17-44. MIT Press, Cambridge, MA.
[10] Leontiev, A.N. (1978) Activity, consciousness, personality. Prentice Hall, Englewood Cliffs, NJ.
[11] Lewis, R. (1995) Editorial: Professional learning. *Journal of Computer Assisted Learning*, **11**, 4, 193-195.
[12] Lewis, R. (1997) An Activity Theory framework to explore distributed communities. Journal of Computer Assisted Learning, 13, 4, 210-218.
[13] Lewis, R. (1998) Apprendre conjointement; une analyse, quelques expériences et un cadre de travail. *Hypermédias et Apprentssages 4*. 11-28. INRP et EPI, Paris.
[14] Light, P. & Glachan, M. (1985) Facilitation of Individual Problem Solving through Peer Interaction. *Educational Psychology*, **5**, 3&4, 217-225.
[15] Linard, M. (1995) New debates on learning support. *Journal of Computer Assisted Learning*, **11**, 4, 239-253.
[16] Littleton, K & Häkkinen, P. (1999) Learning Together: Understanding the Processes of Computer-Based Collaborative Learning. In *Collaborative learning, cognitive and computational approaches* (ed. P. Dillenbourg). Elsevier Science, London.
[17] Nakamuru, M., Hanamoto, K., Tsutsumi, Y., Fukuda, M. & Otsuki, S. (1999) Models and Negotiations for Group Learning Support. In *Advanced Research in Computers and Communications in Education Vol. 1* (eds. G. Cumming, T. Okamoto & L. Gomez) pp. 677-684. IOS Press, Amsterdam.
[18] Nardi, B.A. (1996) Studying context: A comparison of activity theory, situated action models, and distributed cognition. In Context and consciousness: Activity theory and human computer interaction (ed. B.A. Nardi) pp. 69-102. MIT Press, Cambridge, MA.
[19] Ogata, H., Sueda, T., Furugori, N. & Yano, Y. (1999) Augmenting Collaboration beyond Classrooms through Online Social Networks. In *Advanced Research in Computers and Communications in Education Vol. 1* (eds. G. Cumming, T. Okamoto & L. Gomez) pp. 277-284. IOS Press, Amsterdam.
[20] Okamoto, T. (1999) Visual Tools versus Verbal Tools - Towards Creating a New Learning Ecology. In *Advanced Research in Computers and Communications in Education Vol. 1* (eds. G. Cumming, T. Okamoto & L. Gomez) pp. 79-84. IOS Press, Amsterdam.
[21] Schrage, S. (1991) *Shared minds: The new technologies of collaboration*. Prentice Hall, NY.
[22] Schwartz, D.L. (1995) The emergence of abstract representations in dyad problem solving. *The Journal of the Learning Sciences*, **4**, 3, 321-354.
[23] Svensson, L. & Östlund, C. (1999) e-Quality: A Cybergenre for Quality Discussion. In *Advanced Research in Computers and Communications in Education Vol. 2* (eds. G. Cumming, T. Okamoto & L. Gomez) pp. 689-696. IOS Press, Amsterdam.
[24] Von Cranach, M. (1982) The psychological study of goal-directed action: Basic issues. In *The analysis of action: Recent theoretical and empirical advances* (eds. M. von Cranach & R. Harre) pp. 35-73. Cambridge University Press, Cambridge.
[25] Watabe, K. & Yuze, H. (1999) Evaluation of Learning through Discussion in Synchronous Collaborative Distance Learning. In *Advanced Research in Computers and Communications in Education Vol. 2* (eds. G. Cumming, T. Okamoto & L. Gomez) pp. 173-176. IOS Press, Amsterdam.

Towards Intelligent Media-Oriented istance Learning and Education Environments

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The recent astonishing progresses in information technology, computer and information communication hardware and the spread of the Internet have opened a variety of new ways for many fields. Although slower than the business field to catch up with these new developments, the educational field has gradually migrated towards the World Wide Web, mostly under the slogan of free, accessable education, to and from anyplace, at anytime. This development triggered, among other effects, also the important shifting of the weight from the teaching paradigm to the learning paradigm. However, slow network speed hindered the first learning environments from being more than simple, electronic text-books. The latest trends in research are trying to go one step further, making use of increased bandwiths, and integrate various media to enhance learning. Moreover, for obtaining learner-oriented, customized learning environments, ITS and AI-ED techniques are adapted and developed for the Web. These advances promis revolutionary changes in the whole educational system of the new millenium. This paper presents these trends and progresses on one hand, but on the other hand, also addresses the dangers and pitfalls that such an avalanche of changes can bring, and stresses the responsibility we have, to make sure the real goal is never left out of sight: *enhancing and improving learning*. Finally, we show how we tackle this challenge at the Laboratory of Artificial Intelligence, University of Electro-Communications, Japan, where we have built the framework and prototype of an intelligent media -oriented integrated distance education environment.

Keywords: **Learning Ecology, Learning Environments, Distance Education, Multi-media enhanced learning, ITS**

1 ntroduction: the new trends

When in 1995 Schneider [37] was trying to define the levels of WWW use in Education, he suggested the *web as an information tool*, for distribution of learning material, and only as difficult to implement, the *web as a collaboration tool* and the *web for interactive educational applications.*

Four-five years is a long time for the net. Nowadays, opinions have changed. "If the Internet is the next industrial revolution, then net based learning may be the next educational revolution" [40]. "Colleges and Universities have embraced distance learning, doubling the number of courses offered and enrolment in them" in the US [5]. Other countries, like the initially refractory Germany, follow the distance education and wired teaching and learning path [24].

However, not all researchers and educators look favourably upon these changes in the education field. In 1996, Self predicted "a reaction against this apparent dehumanisation of the learning process" [38]. In 1997, Oppenheimer [32] criticized strongly computer in education that, in his opinion, failed to provide what they promised. Moreover, they break down, decrease creativity, teachers are difficult to train, etc. While some of the problems that were brought to light are addressed in current systems, many new problems he hasn't even mentioned appeared. A recent survey of a distance education course showed that distance learning could lead to isolation, anxiety and frustration [16].

Adaptability and collaboration are possible answers to such problems [6], as we will discuss also later on. Moreover, it is equally important to train the teachers first, to be able to use the new technologies [30]. Although the current trend is towards more automatization, and less human interference, the human teacher will still be an important factor in education for many years to come. However, "teachers will increasingly develop new roles as technology-society mediators" [38]. A teacher's role is changing from text based teaching, to facilitating, advising, consulting, and his/her role becomes more that of a designer of the learning environment. Moreover, under the "life-long-learning" paradigm [12], learners are no longer pupils enrolled in the full-time educational system, but part-time, or one-course-only students. Learners' age limits disappear, and the backgrounds can be various (company workers, other employees beside full-time students).

Another important step towards increased learning effect and user-friendliness is the multi-media technology, and, more recently, Video on Demand (VOD). A recent survey showed that "video access would soon constitute a large percentage of WWW bytes transferred on the Internet" [3]. However, many of the new products just give in to the glitter of media, without paying attention to the educational goals. As Shneiderman [39] points out, the educator – and we may add here, also the educational software developer and courseware author - has to have "a pedagogic or curricular destination in mind" and to know that "technology is just a vehicle for getting there".

The current paper presents the three trends in education: distance learning environments (section 2), ITS systems (section 3), and Media-Oriented learning (section 4) first separately, then we discuss the benefits of their integration, pointing also to the possible pitfalls, and giving a short systematic solution about how to avoid them (section 5). Finally (section 6), we describe our own efforts at the University of Electro-Communications towards integrated, intelligent, media-oriented, distance-learning environments and the resulting system, called RAPSODY-EXT. In the end we draw some conclusions and list some yet open questions of the field.

2 Distance Learning and Education

Although the hindrances and problems in building distance-learning environments were and are still various, distance education is here to stay. "Exploring educational frontiers on the Web frightens some professors and maybe some students, but it can also generate unusual levels of motivation and pride in creating something new", says Shneiderman [39]. Many universities offer course modules, whole courses, or even degrees on-line. Moreover, many companies offer all sorts of education-oriented material and educational software via the WWW.

Generally speaking, educational courseware can be designed from scratch, in an **application-oriented** way, or built via **general purpose authoring** tools. Here, one of the new roles of teachers as courseware authors becomes clear. The final product can be built by the teachers/ course designers from scratch, or built with the help of a **commercial** product or **freeware** product.

Moreover, teachers nowadays have to be able to opt to build their own, **off-the-shelf Web course** [20] or to choose among the many **on-line course delivery tools**, like WebCT, Blackboard, eCollege.com, etc. If choosing among the latter, teachers have to decide for the best balance between developmental features, instructor tools, instructional features, student tools, technical support, administrator tools, administrative features, software costs and hardware requirements [23].

Many universities have decided to build their own authoring tools for their faculty staff ([41], [8]).
Basically, although these tools make authoring of web courses easier, one on their main problems is that they "always provide the same look and feel", whereas the off-the-shelf component software can "mimic the style of the typical classroom", according to Kaplan [20]. Moreover, integrated packages actually need more time spent in teacher training, and they don't allow enough creativity for expert users.

We, however, don't see the imitation of the typical classroom as a positive feature. We predict that this imitation tendency will disappear in time - although it may come in handy as being familiar to both teachers and students at the present development state of the distance education environments, and may help in the transition process towards Web-based education. As many researchers noted [40], it makes no sense in trying to only create a copy of the classical education process – which might just lead to bad results, due to the fact that it would only be an incomplete copy - but it is a better approach to try to make use of the advantages which the new environment brings.

- The main advantages of distance learning over the web are, as is well known, the **from – and to any place, at any time** attributes. Often, the **free education** aspect also appears, although much of the offered educational software today is not free, and many educational institutions offer (distance) learning programs at a price.
- Plain, text-based course materials are not enough anymore. The very recent increases in bandwidth made more expression ways possible, images on the Internet are commonplace, sound tracks and videos are used with growing frequency, other **(multi-) media** types evolved (animation, etc.).
- Based on learner modelling [33], also presented in the next section, **adapting teaching strategies** and, generally speaking, **(intelligent) user adaptation** in ITS [44] are being developed. More recently, the field of adaptive hypermedia [10] emerged, at the crossroads of hypertext (hypermedia) and user modelling. *Adaptive presentation of the educational material* can mean one or more of the following: providing prerequisite, additional or comparative explanations, conditional inclusion of fragments, stretch-text, providing explanation variants, reordering information, etc. *Adaptive navigation support* can mean one or more of the following: direct guidance, sorting of links, links annotation [7], link hiding, link disabling, link removal, map adaptation, etc.
- Another main advantage of the Network is that it favours **collaborative work**, which in turn favours learning [11].
- Moreover, distance education finds a justification in the **life-long learning** concept. The recent technological changes are influencing our society, and each member of this society must acquire new knowledge all the time. The age of encyclopaedia brains, and one-time-learnt, good-for-ever educations lies now in the past. Education has to be provided for all sorts of busy people that only sporadically have time to learn, coming from many different backgrounds, with different knowledge levels and various cognitive styles.

In the following sections, we will look at ITS and user modelling and at Media-oriented education, as an answer to the rigidity of the present Web courses and courseware.

3 ITS: learner models, domain models; ITS on the Web

"Traditional ITS presents very little flexibility regarding the pedagogical strategy they use". Moreover, "ITS are usually developed following a fixed strategy that would basically apply to all learners" [2]. Also, "numerous ILE (Interactive Learning Environments) offer a variety of functionalities without taking into consideration their relevancy to the learning process" [27]. Obviously, the only reason of using ITS and/ or adaptive/ interactive methods and (intelligent) strategies should be an educational goal, e.g., faster and/or deeper understanding of the learning material, due to a more appropriate teaching method, etc. A possible user adaptation method is to switch among pedagogical strategies, also called **cooperative strategy contexts** [2].

Pedagogical strategies	**Explanation**
Tutor-tutee	Traditional: computer is teacher, user is student
Learning companion	A computer-simulated learner, to accompany the user [14]
Learning by disturbing	Learning with a simulated troublemaker. [13]
Learning by teaching	Human student teaches the simulated companion. [21]
Learning with a co-teacher	Both simulated teacher and co-teacher

Within these strategy contexts, direct strategies exists, such as: *Learning by examples, learning by story-telling, learning by doing, learning by games. learning by analogy. discovery learning, learning by induction/ deduction*, etc.

To switch between strategies, a **learner model** is necessary [29]. In 1996 already, Greer [15] was pointing towards the importance of taking into account the student's values; moreover, he mentioned that offering adapted activities, producing appropriate feedback, favouring communication between students and offering assistance are crucial. For the correct choice, though, the "student's values, learning style metacognition and preferences regarding feedback" have to be appropriately inferred [27]. Ultimately, the student model has to be mapped on the **knowledge domain model**. The latter represents the model of the course contents knowledge, and is (naturally) domain dependent.

The latest student models contain a layered evaluation of the learner, starting with the classical **knowledge and cognitive model level**, wrapped by the **learning profile**, or curricula. The last wrapping layer to be added is the **believability and emotional layer**, which, if correctly interpreted, is supposed to point to the best learner-tailored pedagogical strategy [1].

The way the system acquires knowledge about the learner varies:

- The most straightforward way is via, e.g., **single/ multiple-choice questionnaires**, where the learner inputs his/her preferences, his/her opinion(s) about his/her knowledge level, learning profile, emotional profile, etc. The exact preferences of the user can be checked in an equally straightforward way via selections during the learning (e.g., pushing of button "utterance" or "question", after some text input, etc. [18]). To the same category belongs also the setting of the environment parameters, such as background color, favourite text size, color scheme, frame layout, etc.
- Another method, which can be used separately, or together with the previous, is to **test the learner**, in order to establish his/her profile. These tests can vary from knowledge tests to IQ tests or even personality tests.
- The last and most difficult of these methods is to **trace the learner's steps during learning**, and interpret the user's choices and results into a learner model [9, 22]. This learner model can then be used to select the learning strategy, etc.

The questioning and testing methods of more or less explicitly gathering information on the learner have the advantage that the information is correct (providing the user knows him-/herself, which is not necessarily always the case). The user-model building is transparent to the learner, who can directly influence it.

As the psychological foundation of user modelling is not yet clearly defined, due to the complexity of the real human mental profile, it is therefore preferable to allow the user to exercise direct influence on the modelling, and to correct eventual misinterpretations. However, this explicit information gathering, although easier on the automatic interpretation side, is leading to a high user overhead. Beside of learning how to use the educational software, and the normal load of learning, the user has to waist a lot of time to tell the system what s/he is and what s/he wants and needs. Frequent user prompting, especially when having nothing to do with the current user focus, can lead to tiredness and even make the student give up. It is also questionable if we can call such systems "intelligent".

On the other hand, however, the implicit tracing of the user method has the advantage that it lets the user concentrate on the subject at hand and doesn't prompt him/her with numerous questions. Their problem is that, without explicit user feedback, the conclusions reached by the system might be wrong, leading to sub-optimal or even inadequate adaptation.

Therefore, it is a fine balance between these three main modelling methods that can lead to optimal strategies. As the current psychological and pedagogical research cannot give us the solution to this balance problem, it is quite possible that practical studies of educational software implementations will provide the answer, and lead not only to the progress of educational software research, but also work as a feedback into the psychology and pedagogy field. We predict that optimal solutions will imply a combination of these methods, with fine tuning between the fuzzy set of goals of *user-friendliness*, a *low user overhead* and, last but not least, *learning enhancement*.

The advantages of introducing advanced ITS user-adaptation methods in Web-based systems, as opposed to stand-alone environments, are as follows.

- Due to client-server architecture, huge servers can store material and model users from tiny client machines, making it possible to add facilities that wouldn't have had **space** on the stand-alone machines.
- Moreover, the **great number of (actual/ potential) users** on the Internet makes user modelling and interpretation of average behaviour, classifications, etc., more meaningful. New directions of user modelling include *nation – and region – oriented classification and adaptation*.
- Last but not least, the whole Internet is loaded with (potentially) useful educational material, and a modern ITS system can make use of **more than just the local data and facilities**.

4 Media-Oriented Learning and Education

Media can be used in Educational Software:

- for building **Virtual Environments** (wherein the whole learning process takes place),
- for enhancing the **user-friendly** aspect of the Educational Software, or, finally,
- for storage and presentation of **media-oriented learning material**, as opposed to text-based learning material.

Nowadays, educational software can present any kind of combination of these features. The most important aspect is, however, the correct balance, towards an improvement of the learning function.

A multitude of stand-alone media-oriented software, multimedia educational software, etc., has been developed in the past years. Recently, however, these technologies started moving towards the net. As the old saying goes, "a picture is worth a thousand words", and photographs, images, clip art on the Internet are commonplace, Shockwave, Flash technology is being used newly for more effects, audio and video have a growing role and are remodelling the "look" of the Internet in general, and the educational Internet in particular. VOD technology emerged, supported by the rapidly increasing bandwidth in WWW transfers [28, 35]. "VOD allows users to browse, query linked text and video databases, author video modules and play back the selected video over the network. This technology is likely to greatly enhance the availability of multimedia information to teachers and adds substantial value to the educational process" [17]. Moreover, systems are being developed which are able to play Multimedia on Demand (MOD) [34], i.e., not only audio and video, but also the numerous other kinds of media that exist today.

Naturally, all these developments have been reflected in the new on-line courses and courseware. Our eyes and years, in conjunction with our brain, form a formidable system that transforms sense data into information, i.e., data with meaning [36]. This is extremely beneficial especially in the education domain. Psychological studies of human attention span, distraction tendency, etc., have shown that variation in presentation is recommended in teaching. Every beginning teacher knows (or should know) that the greatest enemy of knowledge transfer between teacher and student is boredom. However, multimedia as "l'art pour l'art" is dangerous. Riley [36] argues that "'analogue' methods of teaching and learning should not be abandoned and superseded by 'digital' methods unless there are clear cost *and* pedagogical advantages to be had".

Of course, costs are maybe much easier to estimate than pedagogical advantages, which very often can be computed only experimentally, i.e., after using the proposed innovations, and such a drastic remark as the previous one may stop any kind of progress. However, where estimation or evaluation can be done, it should, and course designers and courseware implementers should not only give in to the impact of novelty.

5 Combining ITS, Media and Distance Learning

In this paper, we are predicting that the education of the new millennium will be marked by the combined intelligent, media-oriented, distance-learning phenomenon. Although research in these areas has been done more or less independently, for the emerging distance education to become effective, an inspired merge of these directions is necessary.

Following are the advantages over classroom teaching. The classical classroom teaching method is *limited in time*. (Guided) learning is possible in a *synchronous* mode only. The distance-learning paradigm is the one that can solve these problems. Moreover, a teacher has to speak so most of his/ her students understand him/ her, so s/he will always *address the average pupil*. Addressing each student separately is, of course, tailored to that respective student's needs, but this time period is very often an *idle period for the other students*. Therefore, adaptive, customized teaching environments can become superior to the standard classroom method from all these points of view. Media, on the other hand, can enhance the human aspect of the course contents, working on the believability level and smoothing the transfer from face-to-face teaching and learning to learning in front of the computer. Moreover, media presentations can come as extra clarifications, or even belong to the main contents, etc.

However, in order to enhance the learning effect in building a learning environment, one has to tackle the following questions:

- **Should it be a distance learning system?** I.e., who are the target learners, how far are they from the site? Does their spread justify the distance-learning paradigm? Do we expect an extension of our audience in time, more students from different locations? Etc. This kind of analysis should also clarify the type of distance system needed and the technical aspects of the distance system implementation.
- **Should it be an intelligent, adaptive system?** I.e., are the students very different? Do their backgrounds vary very much? Do the students belong to different age groups? Are they full-time and part-time students? Are there company workers among them? Is the subject of the course of such a nature, that different parts of the contents might be relevant to different people? Do all students have to study the whole material, or should there be alternatives, according to their needs? At what granularity should the course be presented, depending on both the predicted student attention span and smallest unit containing useful information [9]? Etc. These kinds of questions, again, don't only point to the show if an adaptive system is needed or not, but also show what kind of adaptation is necessary.
- **Should there be various media?** I.e., does text suffice for the presentation, or can we expect a better student reaction from different media? Will the media enhance the student motivation, his/ her comprehension of the contents, other learning related matters? What kind of media is appropriate, and for which part of the system (contents presentation, testing, virtual environment building, etc.)?

In the following, we will show how we proceed towards an intelligent media-oriented distance learning and education environment at the University of Electro-Communications (UEC), under the concept of life-long learning, in-service training, career development, information sharing and collaboration. The project is supported by MITI (Ministry of International Trade and Industry) and is part of a larger project called ALIC.

6 An Example: The RAPSODY-EXT project at the UEC

As we have shown as resulting from the current trends in education, nowadays it is extremely important for almost every member of the society to acquire computer communication literacy [26]. The importance of fostering and expanding teachers' practical abilities and comprehensive teaching skills, as well as company workers' IT knowledge, in the sense of life-long learning and career development, with the help of the new technologies (computers, Internet, multimedia) is stressed by many studies [42].

We have built a free and flexible self-training environment, called "RAPSODY" (Remote and AdaPtive educational System, Offering a DYnamic communicative environment),. Moreover, we have extended the current framework of an individual learning support environment to an individual and collaborative learning support environment, that we called "RAPSODY-EXT". We will present a short outline of each system in this section.

Until now, when a teacher or company worker wanted to take an ITE (Information Technology Education) class, s/he had to leave the office or school. Now it is possible to learn about various subjects via virtual Internet schools. Figure 1 shows the 3-D concept of our RAPSODY framework environment [31]. Figure 2 shows how the material on RAPSODY is built by teachers or specialists, via our cell editing and authoring environment, and how the beneficiaries of this material can be various learners, accessing the system remotely from their working place or from their homes.

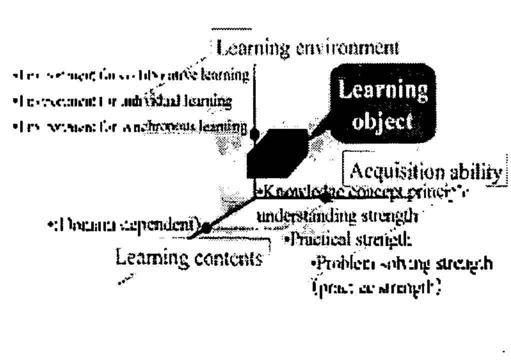


Fig.1 RAPSODY conceptual image

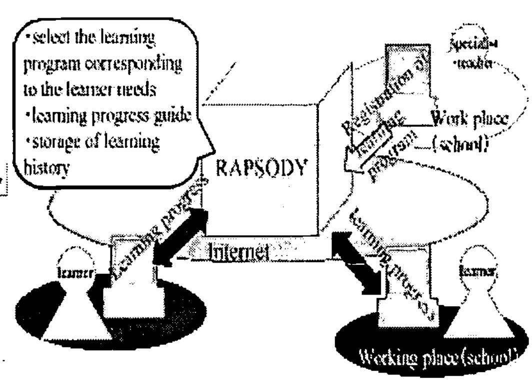


Fig.2 RAPSODY Usage Image

6.1 Distance Educational Model: RAPSODY

Our Distance Educational Model, RAPSODY, is built on 3 dimensions: *learning environment*, *learning contents* and *acquisition ability* (fig. 1). By selecting an item on each dimension, the current learning cell is determined and a cell guide script mechanism triggers the education / training process. For an instance of the RAPSODY concept (a teacher training system) and mo re details, please see our paper [31]. The prototype of our system was built, and some preliminary tests of the functioning system were performed [30]. The hybrid nature of the learning process in RAPSODY, embracing teacher training models, workplace education models and domain oriented learning models is shown in figure 3.

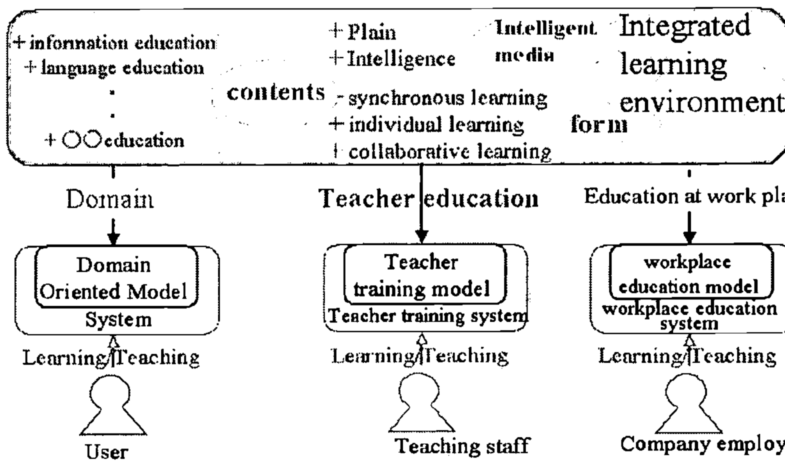


Fig.3 RAPSODY Integrated Distance Learning Model

At the present stage, the RAPSODY system has united the following systems resulting from the research at the Laboratory of Artificial Intelligence and Knowledge Computing:

- a Case Based Reasoning System for Information Technology Education [19], that facilitates the usage and sharing of examples cases of actual ITE practices, via a browsing and search module based on case similarity computation;
- a Collaborative Learning Environment based on three Companion Agents, a novice, an expert, and a facilitator [21], applied successfully on maths and physics teaching;
- a Hypermedia Navigation system [22] based on SOM (Self Organizing Maps) pre-processing and clustering features of the Hyperspace representation, followed by user modelling based on the user history and on a NN (Neural Network) teaching strategy generator, applied on Unix and Hypermedia course contents, and finally,
- a VOD-based distance teacher training system, with basic and adaptive feature search [28], allowing teachers to get familiarized with the new developments in ITE.

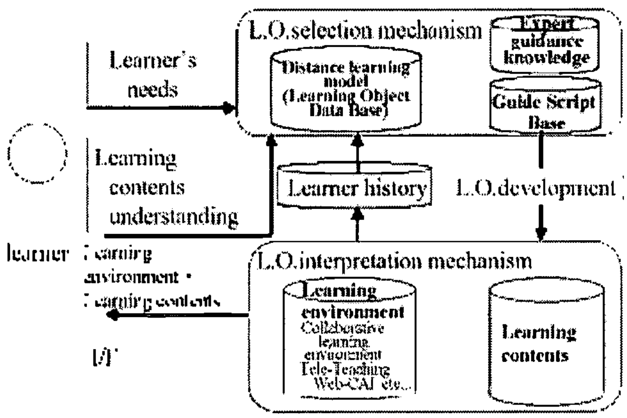
In a following step, the system will also integrate:

- a Qualitative Diagnosis Simulator for the SCS (Space Collaboration System) Operation Activity, supporting Mental Model Forming [29].
- an agent based, adaptive hypermedia distance CALL system for English teaching [9] and
- a discovery learning based CAD (computer aided design) system for learning basics and more about Neural Networks [4].

Moreover, the system allows access to a multitude of individual and collaborative learning tools, like a tele-conferencing environment, supporting environments for problem solving, such as Stella, CASE, distance teaching environments, such as Tele-Teaching, and so on.

6.2 Learning with RAPSODY

The main functions of the learning mechanism in RAPSODY are: identifying the **learning object** that corresponds to the learner's needs, serving as a **learning guide** with the help of a guide-script, and storing the **learner's history**. The learning object is built of *learning goal(s), learning contents, learning steps* and *learning contents understanding verification method*. The selection of the learning object (L.O.) and the user feedback is shown in figure 4. The learner expresses his/ her learning needs via an input interface with various options, in this way determining a cell in the previously shown 3-D model. Based on the guide script and on expert knowledge, the appropriate learning contents is selected – if the respective cell is already pre-defined in the RAPSODY system. Moreover, based on the learner model inferred from the learning history, the appropriate learning environment is fixed. The package of learning environment and contents is then returned to the learner, who can then start the learning process.



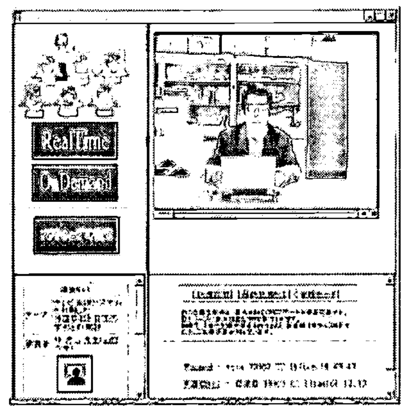


Fig.4 The dataflow in RAPSODY

Fig.5 Learning environment presentation

An example of using real-time, synchronous distance lectures from within the RAPSODY system is shown in figure 5. Moreover, chat windows for collaboration and other explanatory messages can also be seen (e.g., the lower left corner shows the information about the presenter, the university which is transmitting and the theme of the course). The figure also shows that the user can opt for VOD (asynchronous learning option).

6.3 RAPSODY-EXT: Collaborative Learning Environment Extension

The main collaborative learning extensions of RAPSODY-EXT over the previous RAPSODY system include:

- basic equipment of Synchronous /Asynchronous collaborative learning
- Synchronous /Asynchronous collaborative learning materials development facilities
- Synchronous /Asynchronous collaborative learning support function supplement

The extension of RAPSODY-EXT over RAPSODY can be seen in figure 6. The most important are the collaboration learning support tools, that have to do goal oriented work path planning, to select the tool(s) offering the common working environment, to function as a work history registration/ administration tool, and finally, to do manage results. In this way, RAPSODY-EXT becomes a remote and adaptive educational environment and, at the same time, a dynamic communicative system for collaborative learning and WWW synchronous and asynchronous collaborative learning support. Therefore, additionally to the previously enumerated characteristics of the RAPSODY system, the RAPSODY-EXT extended system also features:

- Synchronous or asynchronous collaborative learning group - or individual portfolio construction
- Collaborative activity logging in the collaborative memory
- Portfolio and collaborative memory knowledge management
- Offer of various directory information

We base many of our management function implementations on one of the strongest tools in collaborative environments, **agent technology**, which we have not gone into details about in the current paper. Beside of performing low-level management functions and communication functions, agents can build user models, infer interpretations, simulate students or teachers in the collaborative environment, therefore implying different levels of intelligent processing [11].

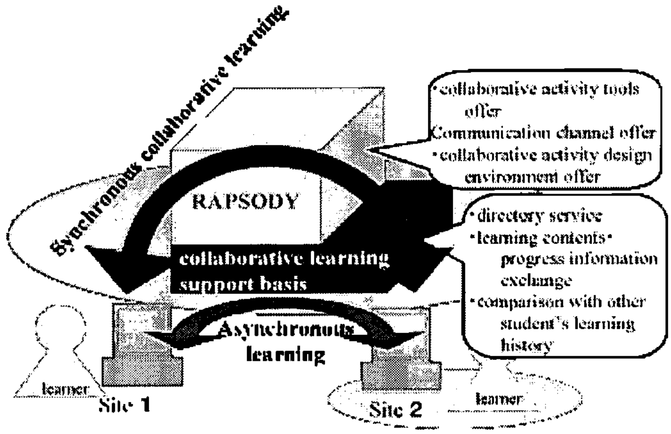


Fig.6 Collaborative Learning environment

6.3.1 Group and individual portfolio construction

In short, portfolio construction takes place as follows. Depending on the collaborative learning style (synchronous/ asynchronous), an individual/ group portfolio is created as a collection of log data about important collaborative activities. Concretely, the following mechanisms are offered: *communication message management* and *knowledge management*. The communication management function is a software acting at a higher level than the learner computer terminal and the collaborative learning management server. Depending on the learner's terminal, the learner data for communication is collected from public and shared applications, is grouped according to the communication message type (data development time stamp, learner ID, message attribute, shared application operation data, etc.) and sent to the collaborative learning management server. On the server, the communication message received from the learner computer terminal is handed over to the knowledge management mechanism. This mechanism does a structure analysis of the message received from the communication message management mechanism, and arranges and integrates the new data with the already accumulated data available in the collaboration learning management database.

6.3.2 Knowledge Management of Collaborative Learning Data

The main goals of the knowledge management in RAPSODY-EXT are to *link the information* stored in the Collaborative memory, such as the worker/learner group history and the portfolio contents to *useful knowledge* for each learner, to *reflect each learning stage*, i.e., to be able to exteriorise not expressed acquired knowledge. In knowledge management, we distinguish between the following two main categories:

Text information management, as in, for instance, *concept information extraction*: extracted concept dictionary, "on the fly" dictionary; *data mining process*: computational (frequency, mutual frequency), conceptual (topic/viewpoint, etc.); *information visualization*: task dependent (word processor, task viewer, etc.), task independent (SOM, state diagram, etc.).
Non-textual information management, as in the *mining process* via information gain machine learning methods: ID3 (C4.5), decision trees; *information visualization*: NN usage: SOM, Symbolic "map" generation.

6.3.3 Directory information

The directory information in RAPSODY-EXT has the role to offer information that accelerates group problem solving, as for example: Problem solving tools, Problem solving FAQ, Group work history, Mutual Group matters (information interchange, exchange), etc.

6.4. Resuming RAPSODY-EXT

We have presented in an extremely concentrated form some of the concepts and ideas of RAPSODY-EXT. RAPSODY-EXT is an individual/ collaborative learning support environment extension of our previous RAPSODY system [31], and stands for the networked virtual learning environment based on a three dimensional representation. The aim of our system is to support teachers' self-learning, provided as in-service training, and company employees' or other learners' studies, under the umbrella of life-long learning. We have realized the foundation of the integrated distance education project and proposed a Self-Development oriented distance-learning model. This system is superior to a simple rule-based instructional plan, as it allows a better and more natural overview of the global structure, as well as a quick identification of missing parts. Our system is therefore a good example of how to integrate various media and intelligent adaptation techniques with distance learning, in a hybrid, goal oriented manner. As shown, RAPSODY already encompasses other distance education projects in our laboratory and is constantly growing. Further on, we need to extend our databases by accumulating various kinds of teaching expertise. In such a way, the concept of " knowledge-sharing" and "knowledge-reusing" can be brought to life. With this system, we can implement various kinds of learning forms and design interactive and collaborative activities among learners. Such an interactive learning environment can provide a modality of externalised knowledge-acquisition and knowledge-sharing via communication processes, and support learning methods such as "Learning by asking", "Learning by showing"," Learning by Observing, "Learning by Exploring" and "Learning by Teaching/Explaining". Expected learning effects are meta-cognition and distributed cognition, reflective thinking, self-monitoring, and so on. As a result, we trust that a new learning ecology scheme will emerge from our environment.

7 Conclusion

As Fischer [12] noted, the new millennium will be marked by the changing of mindsets: the teacher evolving from "sage on the stage" to "guide on the side", the student switching from a dependent, passive role, to a self-directed, discovery-oriented role and by life-long learning. We have to be prepared for these changes, and intelligent, media-oriented distance learning environments are the answer we foresee.

Moreover, we have pointed out that in building such systems, the focus should always be on the learning enhancement and educational goals. Although we have made some suggestions about how to balance the usage of new technologies in view of the learning goals, and how to estimate the effect of introducing them with respect to these goals, one of the main problems with educational systems still remains the difficulty involved in evaluating them. Furthermore, there is no absolute way in which two educational systems can be compared. This field has no benchmarks or standards yet, as some researchers correctly remarked [25]. Although we view setting standards for an emerging field as potentially dangerous, as it can inhibit creativity, we can see a possible benchmarking solution in **simulated students**. Some researchers already have started using such evaluation methods. Although when built by the educational system designers themselves, by following the predicted user model, simulated students might incur tainted results, simulated learners can be useful. *A suggestion would be the design of a pool of students representing the different cognitive styles that can be used by the international research community for system tests.* This might be the answer to the evaluation problem.

As more and more human-like responses and functions are integrated into the remote learning environments, we are faced with a number of questions:

- *How much of the learning can be done solely via remote computer environments, and is there a percentage that will always need human interaction with the human teacher?*
- *How human-like, on the other hand, should these environments be?* Some new research directions go towards integrating emotions, etc. What human features should we mimic in building automatic intelligent teachers, and are there maybe features that should be better left aside?
- *Should we work towards standardization in remote, Media oriented ITS, or should we encourage diversity, as the field is still new, and with a great growth potential?*
- *How will distance learning affect the future generations and humankind in general?* Will there be more isolation? Are distance collaborative environments the answer to that? Will there be internationalisation, as the current trend seems to be? Will this internationalisation in the long run threaten the individual cultures of the different countries, regions, etc.?
- *How much are <u>we</u> modelling the future world of the new millennium, and how much is this world modelling <u>us</u>?* And, finally, and more important:
- *Are these changes actually going to improve life?*

We tried to reply to some of these questions in the current article, making some predictions and showing our opinions.

Our position is that we have to start by teaching our main teaching force, the teachers, and making them first adjust to the new challenges of the coming millennium. A trained teaching force is the one that will model and mark the coming generations. In Japan, the whole education system is going through a revolution and is being gradually adapted to the modern IT world.

At the same time, workers everywhere should be given the opportunity to keep in touch with the new developments and have the chance to improve their career paths via various remote learning systems.

It is difficult to break with old customs on one hand, and dangerous to through away old methodologies, just because they are old, on the other. There is a delicate balance here to maintain, and education, especially, is too important to be merely fashion oriented. We have to choose carefully what to keep from the old ways, and what to change, and we have to educate the future generations to keep an open mind. In this way, we can trust they will be able to make the right choices and build on the basis we are laying out for them.

References

[1] Abou-Jaoude, S., and Frasson, C., Integrating a Believable Layer into Traditional ITS,AI-ED99,Le Mans, France (1999)

[2] Abou-Jaoude, S., and Frasson, C., An Agent for Selecting a Learning Strategy, NTICF 98, Rouen, France (1998)

[3] Acharya, S., Smith, B., and Parnes, P., Characterizing User Access To Videos On the World Wide Web, Multimedia Computing and Networking, MMCN (2000)

[4] Belkada, S., Okamoto, T., Cristea, A., Supporting Discovery Learning in Building Neural Network Models, ITS 2000, Montreal, Canada, 5th International Conference on Intelligent Tutoring Systems (2000)

[5] Blair, J., Colleges, Education Week on the Web, http: //www.edweek.org/ew/ , Jan. 19 (2000)

[6] Brna, P., Collaboration in a Virtual World: Support for Conceptual Learning?, HTI-ET 97, http: //www.cbl.leeds.ac.uk/~paul/papers/hci-et97paper/hci-et.html (1997)

[7] Brusilovsky, P., Methods and techniques of adaptive hypermedia, User Modelling and User-Adaptated Interaction, No. 6, pp. 87-129 (1996)

[8] Collis, B.: Design, Development and Implementation of a WWW-Based Course-Support System. ICCE99, IOS Press, pp.11-18 (1999)

[9] Cristea, A., Okamoto, T., and Cristea, P., MyEnglishTeacher - An Evolutionary, Web-based, multi-Agent Environment for Academic English Teaching", Congress of Evolutionary Computation CEC 2000, San Diego, USA (2000)

[10] De Bra, P., Brusilovsky, P., and Houben, G.-J., Adaptive Hypermedia: From Systems to Framework, ACM Computing Surveys (1999)

[11] Dillenbourg, P., Collaborative Learning, Cognitive and Computational Approaches, Advances in Learning and Instruction Series, Pergamon (1999)

[12] Fischer, G., Lifelong Learning: Changing Mindsets, ICCE 99, IOS (Ohmsha) Press, pp. 21-30 (1999)

[13] Frasson, C., and Aimeur, E., A Comparison of Three Learning Strategies in Intelligent Tutoring Systems, Journal of Educational Computing Research, Vol 14 No 4, p. 371-383 (1996)

[14] Gilmore, D, and Self, J. The application of machine learning to intelligent tutoring systems Teaching, Intl. Conference on the Learning Sciences, AACE (1988)

[15] Greer, J., Student modelling, Student Modelling workshop at the User Modelling Conference, Hawaii (1996)

[16] Hara, N., and Kling, R., Students' Distress with a Web-based Distance Education Course, Information, Communication & Society, also: http: //www.slis.indiana.edu/CSI/wp00-01.html

[17] Hui, S., Video-On-Demand in Education, http: //www.cityu.edu.hk/~cc-ncom/net14/vod2.htm

[18] Inaba, A., and Okamoto, T., Negotiation Process Model for intelligent discussion coordinating system on CSCL environment, AIED 97, pp. 175-182 (1997)

[19] Inoue, H., and Okamoto, T., Case Base Reasoning System for Information Technology Education, ICCE 99, IOS (Ohmsha) Press, pp. 1083-1086 (1999)

[20] Kaplan, H., Building your Own Web Course: The Case for Off-the-Shelf Component Software, CAUSE/EFFECT journal, Vol. 21, No. 4, http: //www.educause.edu/ir/library/html/cem9849.html (1998)

[21] Kasai, T., and Okamoto, T., The Support for Collaborative Learning with Companion Agents, ICCE 99, IOS (Ohmsha) Press, pp. 760-767 (1999)

[22] Kayama, M., Okamoto, T., and Cristea, A., Exploratory Activity Support based on a Semantic Feature Map, Adaptive Hypermedia Conference (AH 2000), Trento, Italy (2000)

[23] Marshall University's Center for Instructional Technology, Comparison of Online Course Delivery Software Products, http//multimedia.marshall.edu/cit/webct/compare/comparison.html
[24] Meissner, G., Closing in on Distance Learning, German institutions start to embrace wired teaching, Educom Review, http//www.educause.edu/ir/library/html/erm9914.html, Jan./ Feb. (1999)
[25] Mizoguchi, R., Ontology Awareness for Intelligent Instructional Systems, ICCE 99, IOS (Ohmsha) Press, pp. 45-52.
[26] Nishinosono, H.: A Teacher Education System for Information Education Teachers at High School Level in the Information Society. Proc. of the conference JET, pp.523-524 (1998)
[27] Nkambou, R., IsaBelle, C., and Frasson, C, Supporting some pedagogical issues in a Web-based distance learning environment, NTICF'98, Conference internationale sur les nouvelles technologies de la communication et de la formation, Rouen, November (1998)
[28] Okamoto, T., Matsui, T., Inoue, H., and Cristea, A., A Distance-Education Self-Learning Support System based on a VOD Server, IWALT 2000, Palmerston North, New Zealand (2000)
[29] Okamoto, T., Cristea, A., Matsui, T., and Miwata, T., Development and Evaluation of a Mental Model Forming Support ITS - the Qualitative Diagnosis Simulator for the SCS Operation Activity -, OZCHI 2000, Sydney, Australia (2000)
[30] Okamoto, T., Seki, K., and Cristea, A., RAPSODY: A Self/Collaborative-Learning Internet and Multimedia Distance Support Model for Teacher Training, IMSA 2000, Las Vegas, USA (2000)
[31] Okamoto, T., A Distance Ecological Model to Support Self/Collaborative-Learning via Internet, ICCE 2000 (2000)
[32] Oppenheimer, T., The Computer Disillusion, The Atlantic Monthly, http://www.theatlantic.com/issues/97jul/computer.htm
[33] Paiva, A., Communicating with Learner Modelling Agents, ITS 96 Workshop on Architectures and Methods for Designing Cost-Effective and Reusable ITSs, Montreal, June (1996)
[34] Parnes, P., Mattsson, M., Synnes, K., and Schefstroem, D., mMOD: the multicast Media-on-Demand system, WebNet 97, http://www.cdt.luth.se/publications/1997.html (1997)
[35] Peltoniemi, J., Video-on-Demand Overview, http://www.cs.tut.fi/tlt/stuff/vod/VoDOverview/vod1.html (1995)
[36] Riley, F., Understanding IT: Developing Multimedia Courseware, http://www.keele.ac.uk/depts/cs/Stephen_Bostock/docs/mmauthor.htm
[37] Schneider, D., and Block, K., The World-Wide Web in Education, ANDREA, Vol. 2, No. 5, June 12 (1995)
[38] Self, J., The Development of the Computer Based Learning Unit: A Discussion Document, http://cblslca.leeds.ac.uk/~jas/discussion.html (1996)
[39] Shneiderman, B., Educational Journeys on the Web frontier, Teaching your students where to go and how to get there, Educom Review, http://www.educause.edu/ir/library/html/erm9861.html
[40] Synnes, K., Parnes, P. , Widen, J., Schefstroem, D., Net-based Learning for the Next Millennium, SCI/ISAS99, Florida, USA. (1999)
[41] Teletop, http://teletop.edte.utwente.nl/
[42] UNESCO Report: World Declaration on Higher Education for the 21 Century Vision and Action, Paris (1998)
[43] Salvador, L. G.: Continuing Education Through Distance Training. ICCE99, pp. 512-515, IOS Press (1999)
[44] Woods, P. J., and Warren, J., Adapting Teaching Strategies in Intelligent Tutoring Systems, ITS 96 Workshop on Architectures and Methods for Designing Cost-Effective and Reusable ITSs, Montreal, June (1996)

Research on Internet Addiction: A Review and Further Work

Chien Chou

The purpose of this article is to review studies on Internet addiction since 1996, including empirical studies conducted in Taiwan. The first part discusses definitions, terms used, and assessment criteria. The second part reviews published research findings on Internet addiction focusing on these issues: (1) Internet usage and time, (2) problems related to Internet addiction, (3) gender difference in Internet addiction, (4) Internet addiction and social-psychological factors, and (5) Internet addiction and attitudes toward computers. Also covered is a discussion on future research directions.

Keywords: Internet addiction, Internet dependence, Internet abuse, Internet pathological use

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